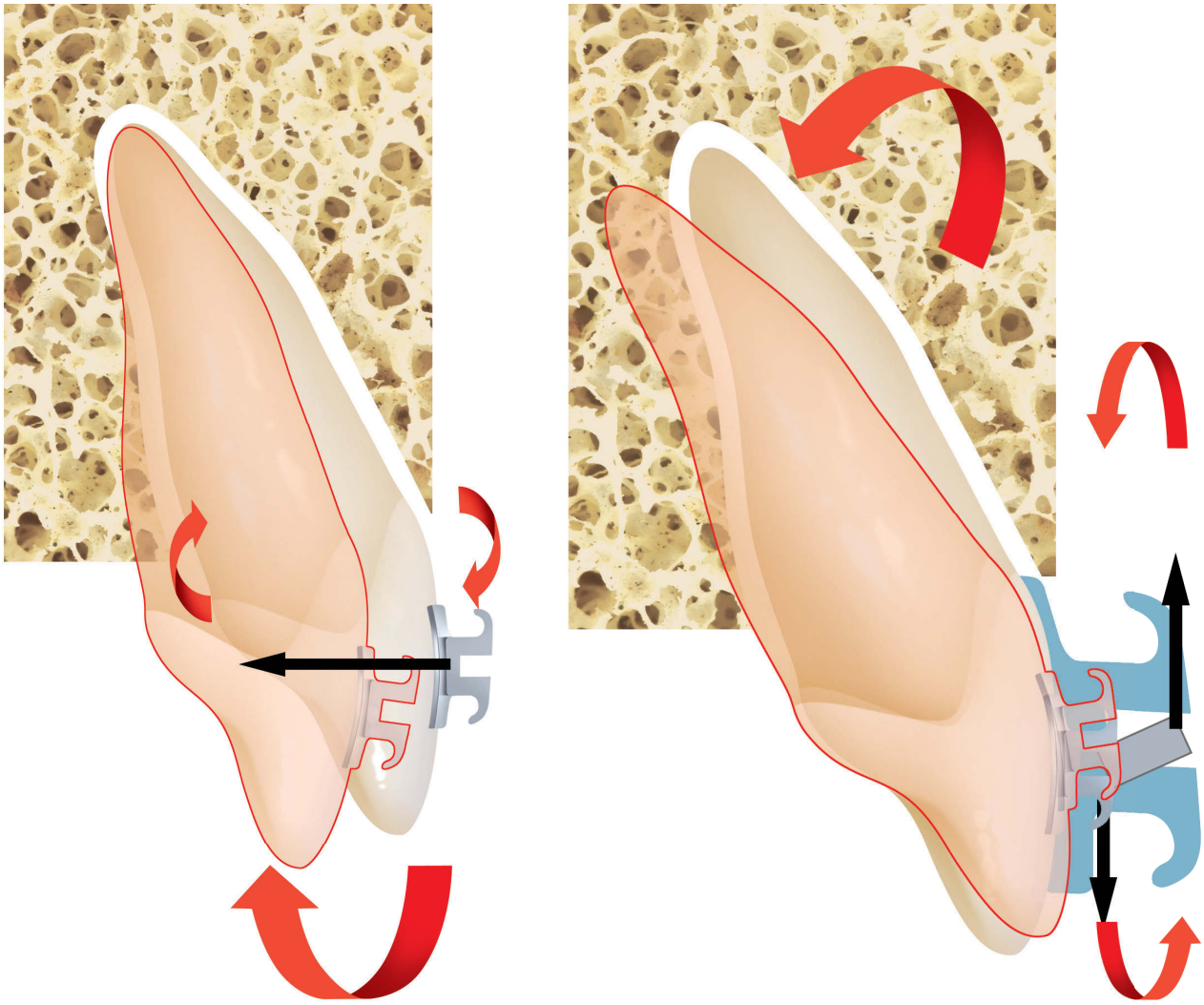
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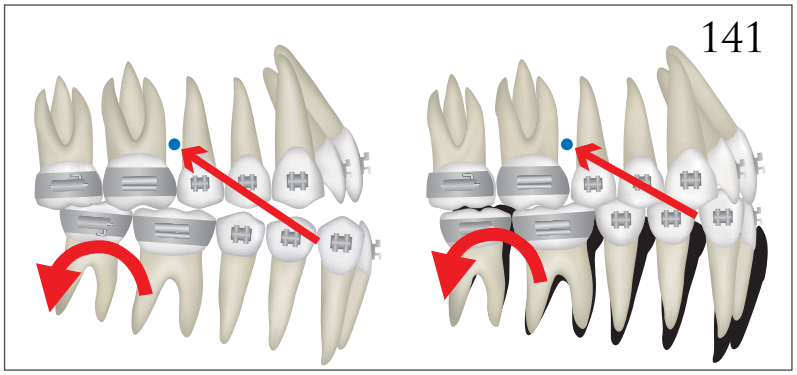
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The clinician and the scientific evidence

No, our science is no illusion. But an illusion it would be to suppose that what science cannot give us we can get elsewhere (Sigmund Freud).

It is noticed a detachment between the shape of published researches and the language used among clinicians. It is no wonder clinicians prefer case reports instead of papers plenty of methodologies and awkward terminologies. The language and imagery of clinical cases are rooted in the daily practice and have the aura of objectivity, for this reason they are assimilated. On the other hand the scientific rigor is blurred by the methodology, what makes it boring. "Narcissus finds ugly what isn't his mirror", says a Brazilian composition.

The Science demands the systematization of methods to which clinicians are not bonded or used to. Nevertheless, many even were not introduced to these methods and neither had any contact with the design of scientific studies during undergraduation, this way it becomes an uneasy, thorny and limping script. Without a basis change only a few will get interest on the evidence-based dental practice while on the top of their professional career. The university is the cradle of the graduation and it has little by little bowed to the necessity of reducing such a distance. For us the right path is to correct this asymmetry and to bring undergraduates closer to the research. It is believed that only this way the future professionals will be able to understand the reasons for giving even more attention for a systematic review than to a clinical case. The issue is how to establish its importance if one does not even know what is a systematic review and its modus operandi?

Recently Prof. Flores-Mir — head of Department of Orthodontics of the University of Alberta, in Canada and also recently interviewed in this Journal[1] — has told that his students since the beginning of the graduation start learning step by step the construction of a systematic review. This publication method is extremely interesting and important for the process of continuous education of clinicians. But, how is it possible to read if we don't understand the process for constructing an article? How to appreciate if when we start reading, the text looks written is Javanese and conjugated in the harder verbal tense, and the methods also look more important than the results? I'm convinced that we need to change the format of scientific publications. This disruption aims at giving lower value to the method, pushing it to the end of the manuscript.

Even in science, changes occur slowly and have to be peer reviewed, that's why they retard to change. However I can see in the Brazilian orthodontics interesting attitudes aiming at the question core. I have been invited to explain in courses of continuing education about the process of formation of the scientific knowledge and the reason of greater trust in some kind of studies and researches. The main objective of these meetings is to provide clinicians the magnificent information that will bring them bigger chance of success in the next clinical case. In May next there will be an event promoted by the 'Associação Paranaense de Ortodontia' (Orthodontic Association of Paraná State, Brazil) focusing to orientate clinicians concerning the importance of scientific evidence for daily practice: A commendable challenge headed by Prof. Alexandre Moro. Also Dental Press in its course of excellence in orthodontics has been doing similar process. It is worth of taking a look.

As participant of the process of developing Brazilian orthodontic science, in combination with the need of bring clinicians a better understanding of the development of scientific research, the Dental Press Journal of Orthodontics will initiate in the second half of 2013 a selection of short papers dealing with the many face of orthodontic science applied to the clinic. This section will be coordinated by the associate-editor Prof. Dr. Fernanda Angelieri. Various researches will be invited to try to make narrower the language between the scientific orthodontics and the orthodontic clinic. The idea is to render the scientific methodology to something more pleasing, trying to raise the logic of the Austrian philosopher Wittgenstein, breaking the glass shards over the walls of language to break through the frontiers of the universe.

David Normando
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1. Flores-Mir C. Interview. Dental Press J Orthod. 2012 Nov-Dec;17(6):13-9.

Special thematic edition "Orthodontic treatment in adult patients"

Dental Press Journal of Orthodontics (DPJO) is glad to announce the special edition with the theme "Orthodontic treatment in adult patients". Authors are invited to submit original unpublished articles related to this theme, following the publishing instructions in the end of the journal. The deadline for submitting articles is May 5th, 2013. All manuscripts will be analyzed through the peer-review system and the accepted ones will be published in the anniversary edition of Sept-Oct, 2013 of the DPJO.

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Matheus Melo Pithon[1]

RAPID MAXILLARY EXPANSION DOES NOT INDUCE SIDE EFFECTS

With computerization of the contemporary world, access to information has become rapid and practical. Following this trend, this has benefited the biomedical field, because nowadays clinicians do not need to wait for a scientific meeting to keep up-to-date. However, with the great amount of scientific information available, what can really be taken into consideration and brought to the daily clinic? With the intention of solving these questions and attempting to separate "the wheat from the chaff", systematic reviews appear with the goal of "fishing" in an "ocean" of information for the most reliable answer to a certain question. In line with this trend and in seeking answers there is an old, but ever up to date topic: Rapid maxillary expansion. Italian researchers assessed whether this procedure would induce side effects in growing individuals.[1] After an extensive search of the literature, they arrived to the conclusion that rapid maxillary expansion does not cause injuries in growing individuals. However, the authors open a parenthesis and emphasize that as a result of the low quality of studies found and available, no scientifically based conclusion could be drawn, leaving the suggestion of conducting future researches with greater methodological strictness.

DO NOT EXAGGERATE WHEN ASKING YOUR PATIENTS FOR RADIOGRAPHS AND TOMOGRAPHS

Röentgen undoubtedly was one of the greatest geniuses of humanity, with his brilliant discovery (the "X-ray"), everything that could not be seen with the naked eye became visible. Since it is not all sweetness and light, in order to achieve this feat, it is necessary for the individual to be exposed to radiation and its known harmful effects. However, the orthodontist who follows-up scientific development and stays alert to new technologies, could think, "I use cone beam computerized tomography which, in a single shot, acquires all the images". Therefore, we ask: With the advent of tomographs, has there been an end to problems with exposure to radiation? What would be the real risks from the point of view of cellular changes in patients submitted to this new technology and to conventional radiographic exams? To elucidate these questions, Brazilian researchers proposed to evaluate the behavior of oral cavity cells submitted to protocols of conventional and tomographic orthodontic documentation.[2] The results found (Fig 1) demonstrated cytotoxicity in cells of the oral cavity submitted to conventional radiographs and cone beam computerized tomography. A larger number of cell deaths were found in the group in which computerized tomography was used. The authors concluded the article brilliantly, pointing out that orthodontic documentation must be done only when necessary, thereby avoiding unnecessary radiographic and tomographic exposure.

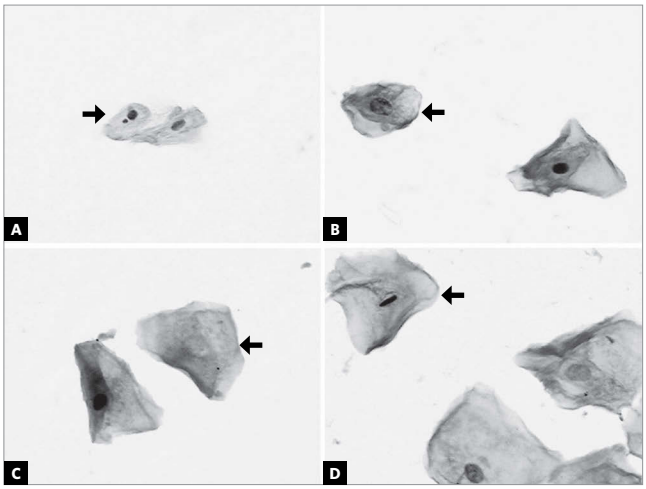


Figure 1 - Evaluation of the nuclear alterations in the cone beam computerized tomography sequence (CBCT) or radiographic exposure (400x magnification, Feulgen/Fast Green stain): cells (**A**) micronucleated (arrow) and normal, (**B**) karyorrhexis (arrow), karyolysis (**C**) (arrow), and (**D**) pyknosis (arrow). Source: Lorenzoni et al,[2] 2013.

[1] Professor of Orthodontics, State University of Southwest Bahia. MSc and PhD in Orthodontics, UERJ. Diplomate by the Brazilian Board of Orthodontics and Facial Orthopedics.

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GOOD TOOTHBRUSHING! NOTHING BETTER FOR PREVENTING WHITE SPOT LESIONS IN PATIENTS USING FIXED ORTHODONTIC APPLIANCE

Much has been developed and commercialized with the aim at improving and even promising to put an end to white spot lesions in patients wearing fixed orthodontic appliances. Mouth wash solutions, remineralizing toothpastes, chewing gums, fluoridated varnishes, among others are used for these purposes. In this context, a pertinent question arises. Are these products really effective in the prevention and improvement of white spot lesions? In seeking an answer to this question, American researchers at the University of Washington conducted a randomized controlled clinical study[3] that evaluated the efficacy of a remineralizing toothpaste and a fluoridated varnish, in comparison with normal brushing with regard to improving white spot lesions. The results attained (Fig 2) refuted the manufacturer's claims, since the authors reached the conclusion that good toothbrushing has the same benefit as the one obtained with the use of these substances.

IT IS POSSIBLE TO OPTIMIZE BONDING OF FIXED RETAINERS

We all know about the importance of orthodontic retention after the removal of fixed orthodontic appliances. There are various methods described in the literature for retention, such as movable and fixed retainers, bonded directly to the teeth with orthodontic composites. As their use does not need patient's cooperation, fixed retainers have been shown to be more effective. But how does one optimize the adaptation procedure of this device, in view of the technical difficulty of direct adaptation because of its lingual location? One of the methods clinicians use to optimize bonding is to perform it without the addition of adhesive resin after acid etching. But what would be the clinical repercussion of this procedure? Swedish, Chinese and Danish researchers conducted a clinical study in which part of the patients had their fixed retainers bonded conventionally with the addition of fluid resin, and another group without performing this stage.[4] The results found demonstrated that clinically, the addition of fluid resin did not influence the longevity of retainer bars. So here is this clinical hint for speeding up your appointments.



Figure 2 - Examples of photos before and after. Source: Huang et al,[3] 2013.

ACCELERATION OF TOOTH MOVEMENT, IS IT POSSIBLE?

Without a shadow of doubt, reduction in treatment time is the orthodontists' dream and patients' wish. But in the light of present knowledge, how can we accelerate tooth movement and consequently diminish treatment time? There are various mechanisms described in the literature, said to be accelerators of tooth movement. Among these: Application of laser, electromagnetic fields, pulsed currents, invasive procedures such as dentoalveolar and periodontal distraction and corticotomies. In an endeavor to elucidate which of the methods would be effective and safe for accelerating orthodontic movement, Chinese researchers developed a systematic review.[5] The authors concluded that low level laser therapy is safe, but incapable of accelerating orthodontic movement, whereas corticotomy is safe and capable of accelerating tooth movement. The other methods need further well designed studies in order to confirm their results. Therefore, in the light of scientific evidence, when a patient requests an accelerated treatment, corticotomy appears to be the option available.

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Effects of medications and laser on induced tooth movement and associated root resorption: Four key points

Alberto Consolaro[1]

The following four fundamental points on the use of experimental models will be described to ensure an accurate evaluation of the effects of medication and laser therapy on induced tooth movement and associated root resorption: (1) If the objective is to check the effect on root resorption, the forces experimentally applied must produce a lesion on the cementoblast layer in all specimens; (2) If the objective is to optimize induced tooth movement and reduce treatment time without side effects, the forces experimentally applied should not produce a lesion in the cementoblast layer in any specimen; (3) The laser therapy operator, the person administering medication and the person that places appliances should not know which animals will effectively receive the test treatment, and the control groups should receive placebo treatments; (4) CT and microscopic analysis of the specimens should be random, and the group to which the specimen belongs should not be identified to ensure that the person reading images and the pathologists are not influenced in their evaluation of phenomena. These measures will ensure that results are more reliable and easier to extrapolate to orthodontic clinical practice.

Keywords: Induced tooth movement. Root resorption. Tooth resorption. Laser therapy. Medication.

Root resorption during orthodontic treatment is a frequent phenomenon, but should not be considered normal or physiological. In numerous clinical cases of orthodontic treatment, apical root resorption is practically inevitable, although predictable when predictive factors are carefully defined.[2]

Although predictive factors are used for analysis, treatment planning often indicates a very high probability of root resorption, which, in such cases, is inevitable and, as long as predicted and explained to the patient, should not be classified as iatrogenic, as it is the biological cost to pay for the esthetic and functional benefits of orthodontic treatment.

Studies have sought ways to speed up tooth movement and reduce orthodontic treatment time. Several factors have been investigated to find ways to reduce the frequency and severity of root resorption during orthodontic treatment. In this search, medi-

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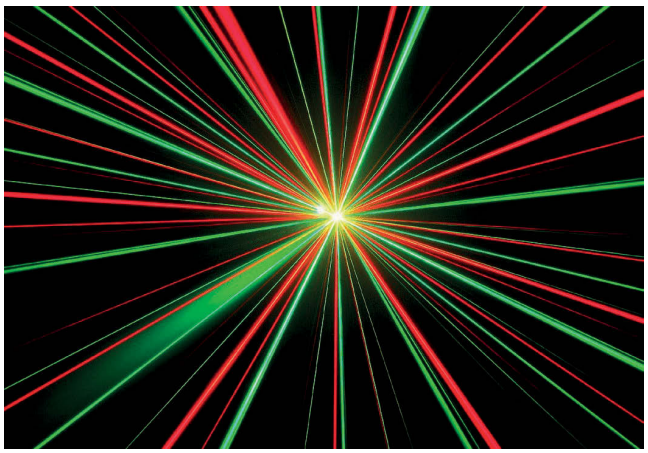
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cations and other tools to achieve those objectives are investigated, such as the use of phototherapy, particularly laser and its variables.

The experimental model of induced tooth movement developed by Henler and Nanda[13] is the one most frequently used worldwide to evaluate the effect of several factors associated with orthodontic clinical practice, and was revised by Ren et al.[21] in 2004. In 2009, Fracalossi et al[6] suggested a standardization of cross-sectional cuts of murine molars for the analysis of phenomena associated with induced tooth movement, and Santamaria Jr[22] described a practical way to quantify it. Still in 2009, Maldonado[19] investigated the effect of medications, particularly analgesic and anti-inflammatory drugs, on induced tooth movement and the frequency and severity of associated induced tooth movement.

The use of phototherapy, particularly laser light therapy, in induced tooth movement has raised the interest of clinicians and researchers. In 2013, Vasconcelos,[25] in his doctorate thesis, found that the use of lower level laser did not affect root resorption induced by orthodontic treatment.

However, using different methods, the effect of phototherapy still requires further experimental investigation due to its many variables, as suggested by reading the main studies published about this topic.[1,3,4,5,7-12,14-18,20,23-26]

We describe four fundamental points for experimental models to ensure that the evaluation of the effects of medication and phototherapy on induced tooth movement and associated root resorption is free of external influence.

THE FOUR FUNDAMENTAL POINTS IN THE CONCEPTION AND DESIGN OF AN EXPERIMENTAL MODEL

Several experimental studies about this topic have not described whether they followed these four fundamental points during study design, planning, method choice and discussion of results:

1. Cementoblast death. *During tooth movement, the root is protected against inflammatory tooth resorption by cementoblasts, which do not have receptors for mediators that interfere with bone remodeling.*

If the objective of a study is to investigate the effect of medications or phototherapy on the frequency and severity of root resorption, the forces of the experimental model should effectively and confirmedly produce lesions on the cementoblast layer, thus eliminating this root protection. The lesion on this layer, and the consequent death of cementoblasts, is the key phenomenon to initiate inflammatory root resorption.

If the experimental model, randomly and in an uncontrolled way, does not ensure that cementoblasts will die in all animals, results about the protective effect of a medication or phototherapy may be compromised. Teeth with preserved cementoblasts does not undergo inflammatory tooth resorption with or without the application of medication or phototherapy.

2. The preservation of cementoblasts*. During desired, ideal and normal induced tooth movement, cementoblasts should be preserved.*

Cell stress and inflammation of the periodontal ligament should not affect cementoblasts during orthodontic movement. The forces applied should not result in the death of cementoblasts when the objective is to test the optimization of tooth movement by means of medication or phototherapy.

Medications and phototherapy does not increase or decrease cementoblast resistance to anoxia induced by the compression of periodontal blood vessels during orthodontic movement. When there is direct and excessive compression of periodontal structures, or even when the tooth being moved applies force to the alveolar bone, medications and phototherapy does not avoid the death of cementoblasts.

When medications and phototherapy are tested to optimize tooth movement and shorten treatment time, the experimental model, as well as the intensity and concentration of forces, should effectively preserve the

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integrity of the cementoblasts layer. Excessive force induces hyalinization of the periodontal ligament and root resorption, which are not part of the desired optimization, that is, tooth movement without collateral damage to periodontal and root tissues.

3. Applications should be blinded. *The phototherapy (laser, for example) operator, as well as the operator that places appliances for tooth movement, should not know which animals will effectively receive the test treatment.* Applications should be performed using identical devices; for example, a unit that applies light and the other that does not, but that is a perfect imitation of a laser unit.

Likewise, the person that administer medications, as well as the operator that places the appliances for tooth movement, should not know whether they are administering or not the test drug or a placebo to the animals. The control group should equally receive a mock liquid medication or tablet so that the persons that administer the medication and feed the animals do not know which animals are in the experimental group.

Only at the end of the experiments should the specimens be identified, grouped and separated according to experimental conditions to which they were submitted, so that there is no other influence than the experimental variable under evaluation.

4. Examiners should not know what animal received or not the test. *As the specimens are prepared for CT or microscopic analysis, the pathologist or radiologist should not know which specimens are in the control or experimental group.* Random examination of each specimen, not separated into groups, should be conducted according to previously established criteria. Examiners should be free of any type of influence when they start examining each specimen separately.

Specimens should be identified, grouped, separated and compared only after the results are recorded. Therefore, only the variable under test will justify or not the differences found.

FINAL CONSIDERATIONS

The use of medications and phototherapy in orthodontic movement should be evaluated carefully and free of interests of any nature, particularly commercial interests. To ensure that the environment is rigorously controlled and free of influences, such as those due to human subjectivity, we described four fundamental points that should characterize any study that uses experimental models of induced tooth movement and associated root resorption:

1. Cementoblast death. If the objective is to check the effect on root resorption, the forces experimentally applied must produce a lesion on the cementoblast layer of all specimens.

2. The preservation of cementoblasts. If the objective is to optimize induced tooth movement and reduce treatment time without side effects, the forces experimentally applied should not injure the cementoblast layer of any specimen.

3. Applications should be blinded. The person applying phototherapy or administering medication and the operator that places appliances should not know which animals will effectively receive the test treatment, and specimens in the control group should receive mock treatments.

4. Evaluators should not know what animal received or not the test. CT and microscopic analysis of the specimens should be random, and the group to which the specimen belongs should not be identified, to ensure that radiologists and pathologists are not affected in their evaluation of phenomena.

These measures will ensure that results are free of subjective influences from investigators and, at the same time, are more reliable and easier to extrapolate to clinical orthodontic practice.

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An interview with

Ajalmar Maia



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It is a pleasure to talk about the life of a winning man. Brazil is rich in stories as the one that I am about to tell in this interview, but poor in acknowledging their value. Ajalmar Maia was born in Umarizal, a small town in the interior of the state of Rio Grande do Norte, Brazil. One of the sons of a large family of humble origins, quite common in the middle of the last century, he started working at an early age as a sales assistant and spent his teenage years in several jobs, which I am not going to describe to avoid losing focus on his greatest virtue: his tenacious quest for knowledge. Even when working very hard, Ajalmar never left school. At the age of 17, he joined the Brazilian Air Force, his second mother in his own words. While in the Air Force, he entered the School of Dentistry of the Federal University of Rio Grande do Norte (UFRN), Brazil. His intelligence, not equaled by many, associated with immeasurable strength to work and determination to learn eventually led him to unequaled success in his profession. Dr. Ajalmar Maia specialized in Orthodontics in the School of Dentistry of Lins and got his Master's Degree in the School of Dentistry of Bauru (FOB), University of São Paulo (USP). He returned to Natal, already a professor at UFRN, and met his wife and fellow dentist, Nair, mother of his three children (Najwa, Nayara and Ajalmar), working companion and life partner. After that, he obtained his doctorate also at FOB/USP. A model of success in private clinic not matched by any I have ever seen in Brazil, he also has time to write several books, from poetry to Dentistry, and dozens of scientific articles. After all that, he returned to Bauru for a post-doctorate program, mentored by Professor Guilherme Janson, one of the interviewers in this section. Professor Ajalmar is more than it all together: writer, poet, professor, airplane pilot, composer that won several music festivals in the region where he lives, and a great fan of Brazilian popular culture. Ajalmar is a rich fruit of the Brazilian Agreste region, who did not give in to the scorching sun and that used education to grow as an example of success in our profession.

David Normando
Editor in Chief

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» Patients displayed in this interview previously approved the use of their facial and intraoral photographs.

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Tell us a little about your history: Your family, your career, why you chose Dentistry and Orthodontics. (Cátia Quintão)

I was born in a small town in the interior of the state of Rio Grande do Norte, in Brazil, in a working-class family. From my mother, a teacher, I inherited abnegation, perseverance and discipline; my father, a construction foreman, was intelligent, had a lot of friends, but was free of concerns.

My first job opportunity was at the age of 10, taking notes for a merchant who was illiterate. It was then that I found out that learning would take me to where I wanted to be. At 11, under my mother's guidance, who was always very concerned about my preparation for the future, I changed jobs and started selling fabrics at a street stand, where I learned everything about that line of business. Above all, that was when I first "went into business". Today this has been hypocritically classified as exploitation of child labor; however, I know that if children do not learn what they should, they end up learning what they should not.

At the age of 14, I was transferred to Mossoró, where I went to junior high and the first year of high school; I worked in sales during the day and went to school at night. I wanted to study in Natal, the capital city of the state of Rio Grande do Norte, but had no means to support myself there. One day, a sales representative came to the shop where I worked and talked about the Air Force, where it was possible to serve and study at the same time. That filled my head with dreams and I enlisted in the Air Force. In 1970, I joined the Brazilian Air Force, and it was then that I could study for the examinations to enter college and to join the School for Air Force Specialists: I passed both. And after that, I studied Dentistry while still in the Brazilian Air Force: "The man is forged in hardship."

I had always felt a passion for Engineering, but, I don't know why, I prepared myself to enter college in the area of healthcare, and was placed 6th in the exam, which would entitle me even to study Medicine. However, as an Air Force man, it was very difficult to study in a full-time course, and I depended on the Air Force money to support myself. Therefore, it was at this time, once again, that divine providence changed my life, as I was chosen to study Dentistry, an area that I was not familiar with and had never been in my plans.

During the course, still in the Air Force, my professors gave me great support and incentive. I was the tutor for an American professor from Seattle, Dr. Roy Velling, who recommended my name for a job as a professor at the Federal University do Rio Grande do Norte (UFRN), which had plans to renovate its program and qualify new professors at that time. After being hired as a professor, I was chosen to take a Master's Degree in the city of Bauru, in São Paulo, where I lived from 1976 to 1979 and completed two Master's Degrees (Pediatric Dentistry and Orthodontics).

After that, I came back to Bauru for my doctorate, in 1989, and a post-doctorate, in 2005. Therefore, I did not choose Dentistry; destiny put it on my way.

I had the pleasure to meet Dr. Ajalmar out of the Dentistry scene, and found a friendly, open person, a family man that loves life. A generous man that has thousands of different interests: capable of flying a plane, producing a music CD, managing business, running a large orthodontic clinic and writing books that contain incredible orthodontic cases. My question is: how is that possible? (Marco Rosa)

We all have talents and versatilities. The trick is not to direct our capacity and skills to a single activity, be it profession, leisure or business, as if it were the whole world. All activities are closely associated, and what you learn in one can develop the other. Therefore, if you have a talent for music, you may have the potential to write, do business, manage an enterprise. The most important is your creative capacity, discipline, balanced boldness and a broad world vision to see the opportunities around us. Today, education (that is, qualification) is available to overcome our limitations and improve our potentialities.

What is the secret to write a professional and financial success story? What do you think is important as an investment to create and obtain maximum benefit from our careers? (Guilherme Janson and Cátia Quintão)

I think it is simple: A good professional education, a lot of training, since there is no champion without training, and practice, essential to keep a professional performance; sensitivity to work simply and effectively;

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a vision, to predict in which way the world is moving; an open mind for the past and future, using perspicacity to assess the positive legacy of one's specialty (orthodontics), what will change, trends and paths into the future; financial education, because none of it is taught in undergraduate courses in the area of healthcare. Moreover, we have to learn with life and think logically.

Financial success comes from one's financial education to transform present gain into future benefit and, later on, you will have a good financial performance and produce enough to enjoy life travelling, studying and growing intellectually.

If you could make time turn back, professionally speaking, what would you do again? What would you do differently? (Cátia Quintão)

Living is a lifelong learning experience. Time shows us where and how we made mistakes, and humility redeems us because of regret that brings absolution. There are some things, attributed to me as referential, that fill me with great joy. It is good to hear people say that my simplicity, friendliness, happiness and playfulness in the way that I deal with people are "door-openers" and characteristics that call their attention. However, many times, under the pressure and in the heat of adversity in college politics and at other crucial moments in my life, when facing meanness, because of my temper and strong personality, the way I said things could have been different, with different results, which has brought me regrets because I did not have, at the time, the wisdom to express myself differently. I have never acted disrespectfully towards people, no matter who they were, but, until then, I had only been in contact with intelligence and had not yet learned about wisdom. And in my self-evaluation, every time I put in practice those qualities praised by my friends, I came off better.

Also, with the knowledge and the 33 years of clinical practice that I have today, I would have a much leaner clinic, with operational costs different from those of the first clinic I built.

Do you believe that it is still worth to be an orthodontist today, with all the contamination of our specialty? (Cátia Quintão)

I thought that I would never, in my whole life, have the chance to answer such vital questions about my profession. This is a singular opportunity.

It saddens me to see what I shall call THE BIRTH, LIFE AND DEATH OF SEVERINA, in honor of the poet João Cabral de Melo Neto. Therefore, I dismally saw Dentistry bloom in the 70s, which allowed dentists to leave the barber's chair for good and leave the artisanal life behind, to move onto the stage of science, which assigned incontestable distinction to our profession. However, our leaders in the several agencies, associations and entities have never understood that, back then, caries was under control in developed countries and that, due to its simplicity and low cost, this would inexorably come to Brazil and change the picture in relation to this disease, turning the "country of toothless people" into the "country of smiling people". But not due to public policies: It was the industry that managed to add fluoride to toothpaste, as fluoride would never be available to all Brazilians through treated water supply.

Today, children will only have significant caries if they are so poor as to not be able to buy toothpaste or if they do not brush their teeth with it. There is no comprehensive program in any university or agency to treat children 0 to 12 years of age and no caries. Indirectly, industry has done that and, in a few generations, certain dental specialties will disappear, and our actions will focus primarily on trauma and agenesis. Therefore, there should inevitably be fewer dentists to respond to such reality. Our problem has never been the number of dentists, but, rather, their distribution and the option for curative activities. Unfortunately, at the time paid university courses bloomed in our country, the success of our profession was threatened, Dentistry did not have leaders prepared to take it into the 21st century, and young dentists are paying for that. While Scandinavia, England and the United States closed down Dentistry courses, Brazil continued moving in the opposite direction and opening new Dentistry courses. Every misstep in Dentistry has an impact on Orthodontics. It is still worthy to study this beautiful specialty, but it has become harder to do it with dignity. To begin with, there is talent and ethics, which are principles that Angle held so high. However, everything will find a solution due to chaos, as there is no plan to recover our professional status. We will have to come to a point at which it no longer pays to be a dentist before courses are closed down and things get back on track. This is a task for the next 30 years.

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For the time being, few orthodontists will prosper. I believe that "it is good when it is good for everyone", and it was like that in my time, as a young dentist.

I know that one of Dr. Ajalmar's main interests is long-term stability. What strategy do you use for treatment completion and retention currently? (Marco Rosa)

With a solid orthodontic qualification, always considering long-term results after 15 years and having a well-established technical, scientific and philosophical bearing, I tried to find out whether our clinical evidence is right and whether findings might be different. In other words, our results and patient satisfaction had to be checked against evidence from scientific research. Some studies[1,2] answered our questions and strengthened our convictions. Basically, we use bonded lingual retainers in the mandible and wraparound retainers in the maxillary arch. Depending on the case, when there are maxillary anterior diastemas, we also use bonded lingual retainers. For Class III malocclusion, we use a night retainer for prognathism, as described by Eschler; in Class II with instability due to surgical mandibular advancement, we complement treatment with a bionator to be worn at night. In fact, stability is achieved with compliance or when skeletal relations ensure good occlusal relations, as well as muscle, functional and esthetic balance. Therefore, our treatment goals are: In terms of skeletal relations, the balance between bones to establish esthetic and functional occlusion, as well as oral and perioral muscle balance; in terms of occlusion, Andrews' six keys to occlusion; in terms of function, the preference is for a pattern of canine disocclusion, or protrusive group disocclusion with incisors protected by canines, absence of occlusal interferences in the functional movements of the mandible, lip sealing at rest, nose breathing and tongue positioned functionally; in terms of esthetics, facial filling as a long-term approach, attractive smile and balanced facial muscles.

What is the importance of deleterious habits, such as tongue thrust, lip incompetence and mouth breathing, and speech therapy treatments in your orthodontic practice? (Marco Rosa)

Poor oral habits change and deteriorate the functional pattern of oral and perioral muscles and affect the pattern of muscle contraction over bone and teeth. Early advice, interventions, or both, while the patient is growing and before habits become acquired patterns ingrained for a long time, are important to redefine a normal pattern of muscle contraction before function markedly affects form. Every time we: (1) refer a child with severe airway obstruction to the otolaryngologist to clear obstruction; (2) advise a child to stop using a pacifier or sucking thumb; (3) expand the palate during deciduous dentition to recover arch form; (4) use appliances to re-educate muscle patterns, particularly to change swallowing patterns, lingual position and lip sealing. We are preventing problems that orthodontists see in adolescence or adulthood when we establish a muscle pattern and follow up irreversible skeletal changes due to functional pattern changes (Figs 1A, 1E and 2A).

Speech therapy plays a role as an important support for orthodontic stability and may be considered a complement to our activities. Therefore, we refer speech therapy to our patients when the morphology of the dental arch or bones suggests that it is possible to learn and establish a normal muscle contraction pattern. This is important to correct inadequate tongue position and swallowing patterns with atypical pressure (Figs 1C, 1D, 1G, 1H and 2B), increase the length of the upper lip in up to 4 mm in the cases of mouth breathing or hypotonic and short (hypotrophic) lip, which promotes good lip sealing and results in an esthetic smile when finalizing an orthodontic case at any stage (early, interceptive or corrective stage). For the surgical cases, in which morphological changes occur suddenly, it is indispensable to undergo muscle reeducation to stabilize the skeletal result achieved with surgery, particularly open bite, Class III and Class II.

Currently, patients have better understanding and are committed to the stability of treatment results. This has contributed to greater efforts by the patient after surgery in speech therapy for muscle reeducation.

You have several orthodontic cases of open bite treated surgically along with your very successful clinical practice. Would you treat them in the same way or differently today? (Guilherme Janson)

Skeletal anterior open bite remains one of the main events of instability in orthodontic practice. Although the

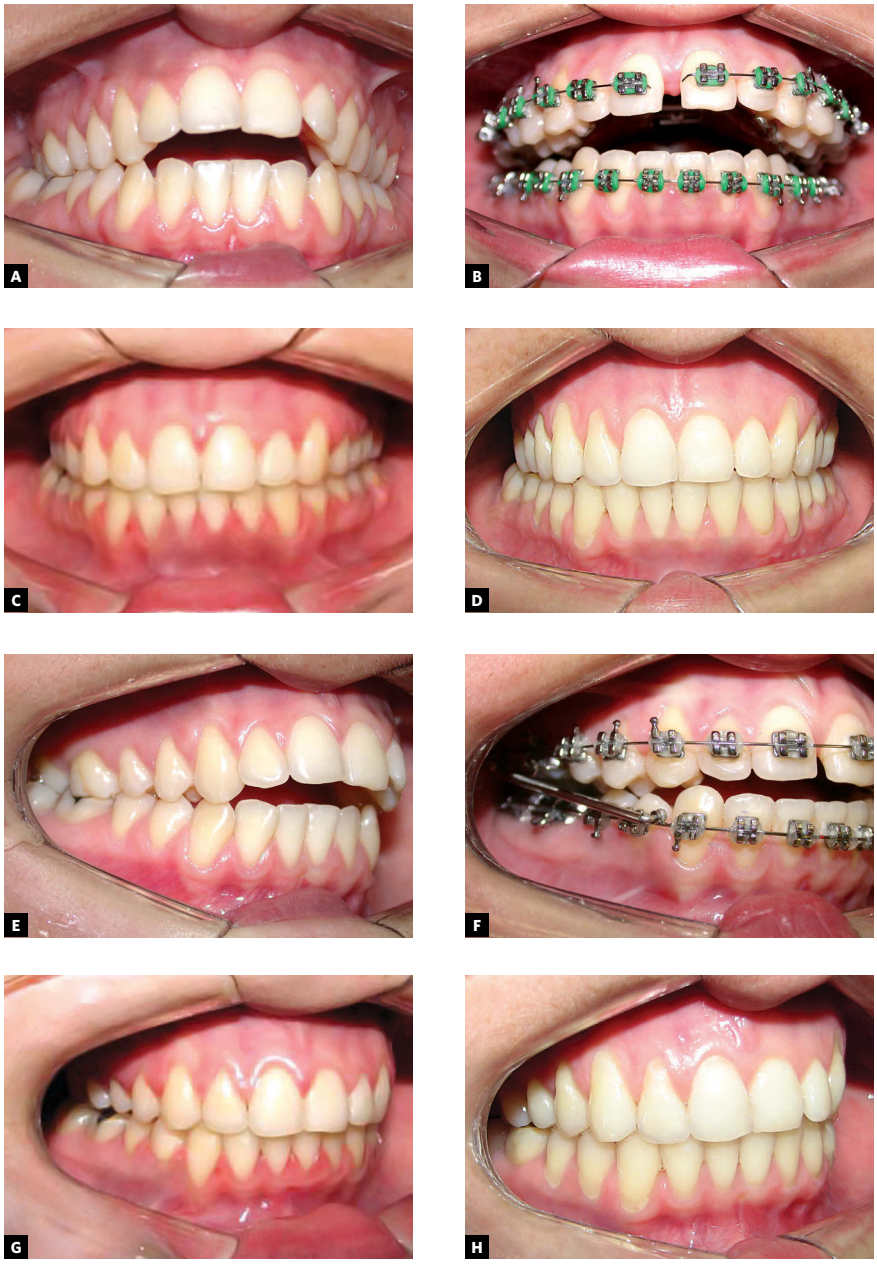


Figure 1 - Baseline intraoral images of a 19.5-year-old patient with a Class II division 1 malocclusion (**A, E**) treated with a rapid palatal expander and a Herbst appliance (**B,F**) at 2 years and 11 months (**C, G**) completed with speech therapy; results are stable 6 years and 6 months after treatment (**D, H**).

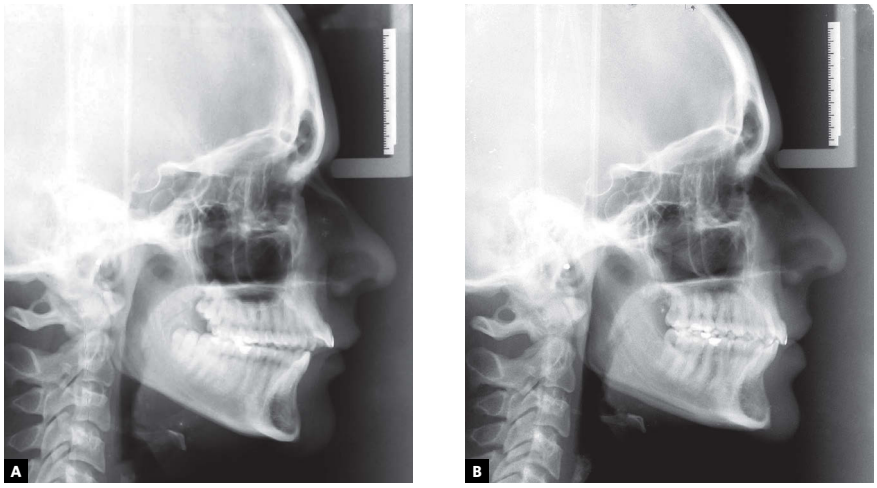


Figure 2 - Baseline cephalogram of patient at 19.5 years of age shows a Class II division 1 malocclusion (**A**); treatment with rapid palatal expander and Herbst appliance for 2 years and 11 months, without surgery, completed with speech therapy, as shown in final radiograph (**B**).

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treatment prognosis is good, it is one of the leading cases of predictable poor stability. Mechanically, orthodontic open bite correction has changed very little: Whereas some authors prefer to level by section, other prefer to align and level the whole arch, which depends on whether the surgery will include segmentation. Treatment principles have changed: Studies have shown that more stability is achieved when surgery includes upper repositioning of the maxilla, particularly in the posterior segment, in cases in which the downward growth of this region affects posterior facial height. Surgery may be performed in the maxilla only, and the mandible may be functionally rotated counterclockwise in the fossa to achieve anterior occlusal contact. This type of surgery also results in good stability when including sagittal mandibular osteotomy with or without rotation of the anterior segment. However, for simplification, some surgeons still prefer to operate on the mandible only and achieve rotation only with the lower jaw. This protocol has proven to be very unstable, and I have always argued against it and discouraged surgeons to use it.

The experience in the surgical and orthodontic treatment of many cases of open bite and an observed instability around 35.8%[3] led us to the development of a treatment protocol that has proven to be very efficient and stable and contributed, moreover, to reducing the number of cases with the type of malocclusion that requires orthognathic surgery as treatment. This protocol[4] recommends extraction of the mandibular first molars and maxillary third molars, reciprocal mechanical anchorage for the retraction of anterior teeth, mesial movement of the posterior segment of the mandible, intrusion of maxillary molars and counterclockwise rotation of the mandible (Figs 3 and 4).

Do you often use intraoral distalizing appliances to correct Class II malocclusion? Do you think they are efficient?

(Guilherme Janson)

I have always been committed to an intensive private practice activity, in which everyday routines are



Figure 3 - Baseline intraoral images of a 31-year-old patient with Class III malocclusion and skeletal open bite (**A, B, C, D**); treatment with fixed straight-wire appliance, without surgery, and extraction of mandibular first molars and maxillary third molars at 2 years and 1 month (**E, F, G, H**); treatment complemented with speech therapy and stable results 6 years after treatment (**I, J, K, L**).

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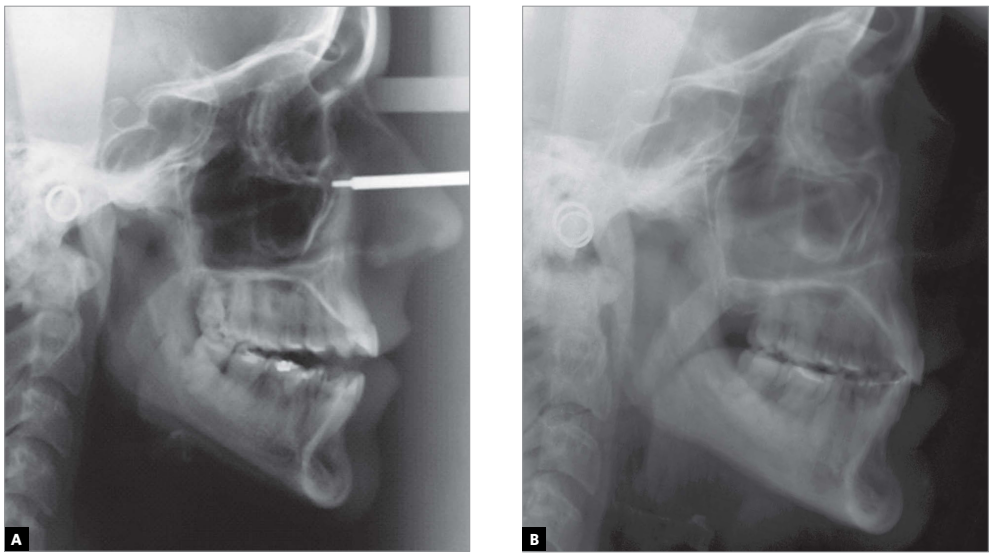


Figure 4 - Baseline cephalogram at 31 years of age shows open bite (**A**). At treatment completion, open bite was corrected without surgery (**B**), with extraction of teeth 18, 28, 36 and 46; 2 years and 10 months after treatment.

very different from the treatment of patients in courses and schools. The levels of cooperation and demand are different. Therefore, the dentist should be sensitive and work with what works, with devices that the patients wear, that do not result in effects that make the treatment longer, and that are under the control of the orthodontist. Studies have confirmed that the different types of distalizing appliances (Headgear, Pendex, Jones jig, Herbst, Jasper Jumper, etc.) work. However, the appliances that yield the best clinical results and have great predictability and control are the appliances that work as the Herbst system (Figs 1 and 2). The tandem system of sliding mechanics and Class II elastics also works well in mixed dentition.

Your interest for the treatment of tooth transposition is well known, also by your publications. Considering the perspective of someone who knows how to deal with it, how much and when is it indicated to accept maxillary canine-premolar transposition?
(Leopoldino Capellozza Filho)

The opportunity to treat an expressive number of transposition cases made me understand the main hurdles to be overcome: (1) preservation of buccal cortical bone; (2) conditions for root repositioning during transposition reversal; (3) efficient mechanics; and (4) lingual canine torque and buccal first premolar torque (Fig 5). The first two limitations may be overcome at the time we move the first premolar lingually. These cases can be treated if we take that principle into consideration and use effective mechanics.[5,6,7] However, in cases of alveolar narrowing, recession of the buccal bone plate, gingival retraction indicating periodontal compromise or advanced age, transposition should be accepted.

What were the greatest changes from the orthodontics that you learned in school and the one that is recognized today as contemporary practice? Were the major changes conceptual or technological? Have advantages been greater for dentists or patients?
(Leopoldino Capellozza Filho)

Changes have been enormous. We learned orthodontics using the edgewise technique and manufacturing all the bands. We had extraoral anchorage in practically all cases; numerous extractions, especially premolars; diagnosis and planning mostly according to cephalometric measurements and the mandibular incisor as the basis; important orthodontic interventions in the maxilla, as the mandible presented several limitations for traditional orthodontics; orthodontics was limited to growing patients and contraindicated for adults because of the high risks of root resorption. This has all changed, and technological advances have been fundamental for changes: Direct bonding, straight wire, shape-memory nitinol wires,

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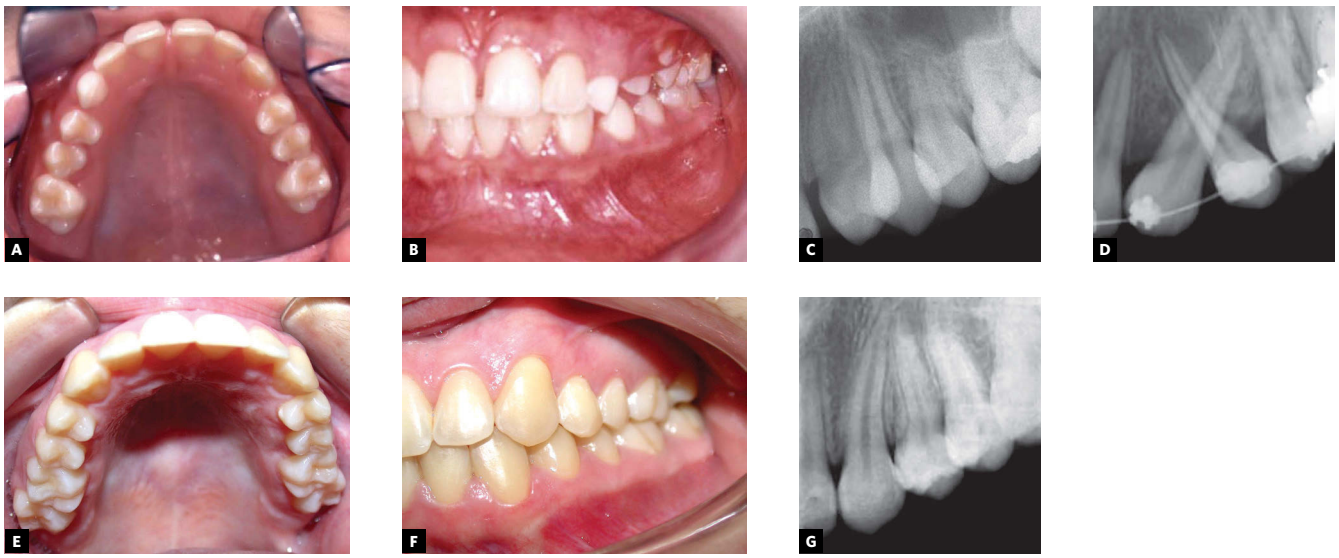


Figure 5 - Baseline intraoral view of an 11.5-year-old patient with Class I malocclusion and maxillary left canine-first premolar transposition (**A, B, C**); treatment with fixed straight wire appliance and reversal of transposed roots (**D**); at 2 years and 3 months (**E, F, G**).

mini-implants, computer-assisted cephalometry, computed tomography, etc. However, the crucial turning point was the conceptual change or, often, the changes in the comprehension of certain phenomena, which have not changed, but which we, orthodontists, now understand differently.

The major changes have been:

1) Individualized planning, with major attention to the face and using the nasolabial angle (NLA) and the position of the maxillary incisor as references.[8,9]
2) Class II treatment with greater attention to the mandible. I have not used extraoral appliances for distal movements in the maxilla for over 15 years. Studies helped us to understand that in the Class II division 1 malocclusion, the maxilla, according to the NLA, is found in both mixed and permanent dentition: Slightly retruded in 45% and 53%; and protruded in only 5% and 5%. Based on the SNA, the maxilla in the mixed and permanent dentitions is: Well positioned in 23% and 15% of the cases; retruded in 27% and 35%; slightly protruded in 35% and 35%; and protruded, but not affecting facial appearance in 15% and 15%. In contrast, the mandible (SNB) in the mixed and permanent dentitions is: Well positioned in 18% and 20%; retruded in 60% and 70%; and protruded in 22% and 20%. Therefore, the major problem Class II cases is the mandible.[10] These data confirm results reported by McNamara[11] and suggest that we treat Class II cases based on the mandible following Kingsley's concept of jumping the bite, which Europeans applied to functional maxillary orthopedics and that, thanks to technological advances, was revived for fixed orthodontics after the development of new versions of the 1909 Herbst appliances, reintroduced by Pancherz[12] in 1979.
3) Implants, such as mini-implants and miniplates, used as intraoral anchorage substantially changed the concept of anchorage and ensured greater efficiency for orthodontists and less collaboration from patients, as cooperation often depended on the patients only and was decisive for treatment success or failure.
4) The difficulty in deciding whether to extract or not led us to publish the basic assumptions and strategies that we routinely use to achieve 5% to 8% extractions only.[13] In contrast, technological advances increased our accuracy in orthodontics, and now we have more control, even in the molar region, and that is an alternative for extractions. This may change results of facial filling in comparison with cases of premolar extractions.
5) Orthodontic treatment in adults was a revolution of its own. However, emerging concepts, defend-

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ed by some authors, about the possibility of facial growth until about age 30 years led some authors, such as Ruf and Pancherz,[14] to successfully treat, without extractions or surgery, numerous cases of Class II malocclusion earlier classified as surgical extraction cases, and followed them up to control stability in the long term.

Therefore, there were mutual benefits, and results were positive for both patients and orthodontists after these changes. Contemporary advances in orthodontics are marked by: more beautiful faces and smiles with better facial filling and improved longevity due to planning that assigns priority to the face; intraoral anchorage for the treatment of Class II malocclusions associated with mandibular deficiency; reduction of the percentage of extractions and alternatives other than premolar extractions, previously practically the only option. At the same time, the treatment of a large number of very stable Class II division 1 and division 2 cases in adults without extractions, as we have used for some years, emerges as the extraordinary change for the near future.[15]

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Evaluation of radiographic magnification in lateral cephalograms obtained with different X-ray devices: Experimental study in human dry skull

José Rino Neto[1], João Batista de Paiva[2], Gilberto Vilanova Queiroz[3], Miguel Ferragut Attizzani[4], Hiroshi Miasiro Junior[4]

Editor's summary

Lateral teleradiographs present extreme relevance in Orthodontics as they demonstrate the relationship of the bone bases and dental relations, besides providing indispensable measures to the orthodontist in growth analysis, diagnosis, treatment planning, therapy monitoring and evaluation of results. Some factors that have great influence on image formation in teleradiographs are: Radiographic distortion, radiographic magnification and errors in the delimitation of the measurement points and cephalometric variables. The objective of this study was to evaluate the influence of radiographic image magnification factor in angular, linear and proportional measurements in cephalometric tracing.

Fourteen lateral cephalograms were obtained from a dry human skull with metallic spheres of predefined dimensions, in different devices from three manufacturers: Panoura, Instrumentarium and Tomeceph. After obtaining the teleradiographs, they were scanned. The cephalometric points were marked on the radiopaque images regarding metallic spheres, using the program Radiocef. The program obtained the angular and linear cephalometric measurements. Pearson' correlation test was used to verify the relationship between the rate of radiographic magnification and cephalometric measurements analyzed.

The results confirmed the small change that the angular and proportional measures are subjected to when varying the magnification factor. Linear measurements derived from cephalometric points located in the median sagittal plane presented dimensional changes similar to linear measurements which have as reference the points located in the lateral region of the face. It was observed a high positive correlation between the magnification of the images, regardless of the location of the cephalometric points that generated these measures. The teleradiographs performed on different devices of the same brand did not represent uniformity of measurements. The authors emphasized that it should be avoided the comparison of linear cephalometric measurements from different x-ray machines, even from the same brand and model. Or, alternatively, it should be used a ruler allowing to standardize the magnification rate between radiographs taken on different devices.

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Distal movement of upper permanent molars using midpalatal mini-implant

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Editor's summary

Conventional intraoral distalizers provide effective distalization of the maxillary molars associated with their distal tipping and loss of anchorage, i.e. mesial/buccal tipping and mesial movement/protrusion of maxillary premolars and incisors. Because of that, intraoral distalizers supported by implants/temporary anchorage devices (TADs) inserted in many intraoral regions were proposed, one of them the midpalatal suture, posterior to maxillary molars. For this device, the distalization force is applied from this TAD to a transpalatal arch on the maxillary first molars by means of chain elastics, with the point of force application placed above the center of resistance of maxillary molars. The aim of the present study was to verify the biomechanical changes of maxillary molars after their distalization by means of transpalatal arch associated with TAD inserted in the posterior region of the midpalatal suture. An acrylic model was used, in which after making a groove, the acrylic teeth were fixed by wax. A 0.019 x 0.025-in stainless steel archwire was placed on orthodontic fixed appliance and a transpalatal arch with two hooks was cemented to the maxillary first molars. Two chain elastics from the transpalatal arch to a TAD, inserted in the region corresponding to the midpalatal suture (posterior area), released a mean force of 300 gf. The model was immersed in water at 60 °C, for 5 minutes and six occlusal and lateral photographs were obtained before and after the immersion, to measure the tipping and rotation of the maxillary first and second molars and the quantity of the molar distalization. This experiment was performed on five models, and repeated forty times per model. Two hundred and forty photographs were obtained per model, resulting in 1200 photographs. For the evaluation of changes that occurred after the maxillary molars distalization, the paired *t* test was employed ($p < 0.05$). The results showed that the maxillary first molars moved distally 3.1 mm (right side) and 3.2 mm (left side), with distal rotation of 1° and distal tipping of 3° (right side) and 5° (left side). The maxillary second molars demonstrated greater distal rotation (3°), with distal tipping of 5°. The authors conclude that the molar distalization associated with TADs inserted in the midpalatal suture associated to a transpalatal arch did not produce anchorage loss. On the other hand, collateral effects on maxillary first and second molars were observed as distal tipping and rotation.

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Determination of the force systems produced by different configurations of tear drop orthodontic loops

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Editor's summary

Orthodontic treatment with extractions requires specific mechanics for space closure. The mechanics for space closure by means of loops on continuous or segmented archwires provides a controlled orthodontic movement with adequate biological forces. The teardrop loops have been commonly used in Orthodontics. However, there are few studies regarding the intensity of the force released by teardrop loops built with different metallic alloys, with or without a helix, and the magnitude of the gable bends. The aim of the present study was to compare the force produced by teardrop loops made of stainless steel and titanium molybdenum alloy (TMA) wires, with transversal sections 0.017 x 0.025-in and 0.019 x 0.025-in, with and without a helix, up to maximum activation of 5 mm. Eighty teardrop loops were distributed into two groups: Group 1 = teardrop loops and Group 2 = teardrop loops with helix. These groups were subdivided, depending on the alloys used (stainless steel or TMA) and the transversal sections of the archwire (0.017 x 0.025-in and 0.019 x 0.025-in), resulting in 10 loops per subgroup. Gable bends of 0° and 40° and activations up to 5 mm (evaluated on each 1 mm) were tested on a universal testing machine (Instron Inc., United States of America). The data were submitted to the Analysis of Variance followed by Tukey's test ($p < 0.05$). The results showed that the greater force released by teardrop loops was observed with a 0.019 x 0.025-in stainless steel archwire, and a 40° gable bend. Furthermore, teardrop loops with a helix produce lower force, decreased by 23% for stainless steel and 30% for TMA wires. The teardrop loops made of TMA release lower forces than the stainless steel ones, being the type of material the most important variable affecting the force magnitude. The authors conclude that all teardrop loops with no gable bends (0°) generate low moment/force ratio, leading to uncontrolled tipping. On the other hand, with a 40° gable bend teardrop loops with a helix produce greater moment/force ratio, enough to promote orthodontic movement with controlled tipping.

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Evaluation of the susceptibility to pigmentation of orthodontic esthetic elastomeric ligatures

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Editor's summary

The increased demand for a treatment that aims a more pleasing esthetics, forced fixed appliances to have esthetic accessories, such as elastic ligatures in colors that are similar to esthetic brackets. With the aim of maintaining the esthetic appearance for the longest time possible, and assuming that these ligatures undergo pigmentation when exposed to some types of foods, it is important to assess the pigmentation susceptibility of these materials to these types of foods. Thus, the objective of this study was to evaluate, *in vitro* the susceptibility to pigmentation of esthetic elastic ligatures (clear and pearl color) of different brands. A total of 60 ligatures were evaluated divided into twelve groups according to the brand used and the normal or stretched condition. The groups were divided into: Morelli clear, TP Orthodontics clear, American Orthodontics clear, Unitek/3M clear and American Orthodontics pearl and Unitek/3M pearl, separated as to the normal and the stretched condition (n = 5). The assessment of staining changes was performed by means of digital photography and computer analysis using the Adobe Photoshop software. Standardized digital photographs were taken at the times T_0 - before the pigmentation process, with the ligatures in normal state, and T_1 - after pigmentation process, which lasted 5 days. The pigment solution used was composed of artificial saliva and foods with staining potential. At time T_1 the ligatures were in the stretched condition and in normal condition (without stretching). The results demonstrated that esthetic elastic ligatures are susceptible to pigmentation. Among the commercial brands evaluated, TP Orthodontics clear and American Orthodontics clear were the most stable, but Unitek/3M pearl demonstrated statistically significant changes in all assessed variables. Thus, the authors concluded that the evaluated esthetic ligatures are likely to pigmentation, with no difference among them in terms of their condition during the process of pigmentation, i.e. whether stretched or not, except for TP Orthodontics clear, which pigmented more when stretched. Despite this tendency to pigmentation, TP Orthodontics and American Orthodontics clear ligatures were more stable regarding this susceptibility to color change. On the other hand, Unitek/3M pearl presented greater propensity to pigmentation.

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Class II malocclusion treatment using high-pull headgear with a splint: A systematic review

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Editor's summary

Class II malocclusion can be of dental and/or skeletal origin, involving mandibular deficiency, maxillary excess, or a combination of both. In patients presenting vertical growth and Class II malocclusion it is necessary to control the vertical effects of the applied mechanics. High-pull headgear (HPHG) is one of the most common appliances to handle this problem, mainly when it is associated to an occlusal splint. To date, the treatment effects of HPHG have not been systematically studied. This way, the purpose of this study was to systematically review clinical studies that have evaluated how HPHG with an occlusal splint affects Class II hyperdivergent growing patients.

Electronic literature survey was performed covering the period from 1966 to 2008 and a total of 442 studies were identified. Only randomized controlled trials (RCTs) or non-randomized controlled trials were included. Modified diagrams based on pitchfork analysis were used to summarize the rotations, displacements and tooth movements associated with the HPHG treatments. Rotations were based on the angular changes of the palatal plane and mandibular plane. Vertical and horizontal tooth movements were based on maxillary and mandibular superimpositions.

Based on the information provided in the titles and abstracts of the 442 articles identified, only four studies met the inclusion criteria. All studies showed significant posterior displacement of the maxilla and distalization of the maxillary molars. Inconsistencies in the maxillary teeth were described regarding molar intrusion and retroclination of the incisors. None of the articles showed effects on the anteroposterior position of the mandible. Only one of three studies that evaluated the palatal plane angle showed significant backward (clockwise) rotation between treated and control groups. In general, studies have shown that HPHG with occlusal splint is effective to redirect or restrict maxillary growth. The HPHG produced improvement in skeletal and dental anteroposterior relationship, but had no influence on the vertical relationship.

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Class II malocclusion treatment using Jasper Jumper appliance associated to intermaxillary elastics: A case report

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Introduction: Skeletal, dental and profile discrepancies can be amended by using functional orthodontic appliances.

Objective: This study is a report of the treatment of a patient, 11 years and 4 months old, with Class II, division 1, malocclusion, convex profile, protrusion of upper incisors, pronounced overjet and overbite, and mild crowding.

Methods: The patient was treated with a Jasper Jumper associated to fixed appliances for 6 months and Class II intermaxillary elastics (3/16-in) during the last 4 months. After debonding, a Hawley retainer was used during daytime and a modified Bionator for night use during one year. In the lower dental arch a bonded lingual retainer was used. This treatment combination improved the profile, as well as the overjet, overbite and molar relation.

Results: There was clockwise mandibular rotation and increase of lower anterior facial height. The lower incisors were protruded and extruded and the lower molars were extruded. The centric occlusal relation was checked and it was coincident to the maximum usual intercuspation.

Conclusion: It was demonstrated that the Jasper Jumper is an efficient alternative to Class II malocclusion treatment, providing improvement in the facial profile, although the changes are more dentoalveolar than skeletal.

Keywords: Angle Class II malocclusion. Corrective orthodontics. Functional orthodontic appliances.

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» Patients displayed in this article previously approved the use of their facial and intraoral photographs.

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INTRODUCTION

The Class II, division 1, malocclusion, is well studied in Orthodontics, being responsible for 12 to 49% of the occlusal problems.[5,7] The most common feature in this type of malocclusion is the mandibular retrusion.[9] Therefore, the redirection of the mandibular growth is the main objective of the Class II treatment. Another treatment goal is the reduction of overjet and overbite and the achievement of molar Class I relationship in a one phase non-extraction treatment.

Besides the skeletal discrepancy, the facial profile can be improved with the use of functional appliances. Several protocols and appliances can be used for this type of treatment, depending on age, sagittal discrepancy and patient cooperation.[11] The beginning of a Class II combined treatment uses mechanics with the purpose of increasing the efficiency of the conventional treatment for this malocclusion, besides it requires less patient cooperation. This technique combines orthodontic and orthopedic mechanics in one phase treatment with fixed appliances.[2]

The Jasper Jumper is a fixed functional appliance considered as an effective option for Class II, division I treatment.[1,10,14] It is made of a flexible intraoral power module, which is comparable to the Herbst appliance, with the advantage of flexibility, and is considered excellent due to great toleration by patients. This appliance was developed to perform light and continuous forces for Class II correction, simulating the effects of the headgear and the activator appliances.[3,6]

On its effects, this appliance corrects the malocclusion by dentoalveolar changes, being useful in cases where growth has ended or is going to end.[12] Another indication is for those patients that refuse orthognathic surgery. This appliance eliminates the need for patient cooperation,[11] but when it faces constant breakage and repair, they can transfer the collaboration to the professional.

Although a number of studies show the clinical efficiency of this appliance on the correction of the Class II, division 1 malocclusion, there are few clinical cases published in the literature.

HISTORY AND DIAGNOSIS

An 11,36 year old boy, with Class II, division 1, malocclusion, in the permanent dentition, with protruded upper incisors, mild crowding of upper and lower incisors, 7 mm overjet, 5,2 mm overbite, convex profile and poor oral hygiene (Figs 1 and 2) sought treatment at the orthodontic clinic of FOB-USP.

TREATMENT OBJECTIVES

1. Correct the molar Class II relationship to a Class I with a mutually protected and maximum intercuspated occlusion.
2. Retraction of upper incisors to correct the overjet and achieve an acceptable interincisal angle.
3. Improve the facial profile by correcting the overjet.
4. Achieve a nice smile providing vertical dimension and reducing the overjet.
5. Ideally align the completely erupted permanent teeth and correct the upper midline discrepancy.

TREATMENT ALTERNATIVES

Three alternatives were offered to the patient and his parents: (1) The use of a headgear, (2) Jasper Jumper appliance associated to fixed appliances, (3) extraction of two upper premolars. They chose the second option, which required less patient cooperation.

TREATMENT PROGRESS

The patient was instructed on oral hygiene before appliance placement. Brackets of the straight arch technique (Roth system, slot 0.022-in. Morelli®) were bonded, as well as bands with triple tubes with a palatal bar cemented to the upper first permanent molars to increase stability and prevent side effects. The leveling and alignment lasted five months (Fig 3) and continuous archwires were used with the following sequence: 0.016-in NiTi; 0.018-in SS, 0.020-in SS and 0.019 x 0.025-in SS. The mandibular arch was tied back to the first or second permanent molars. On the upper arch, the Jumper was inserted in the round tube of the first molars with a ball pin. On the lower arch, the Jumper was inserted in the rectangular archwire with a stop and acrylic spheres over the distal side of the canine bracket. The Jasper Jumpers were selected according the manufacturer's instruction. A rectangular 0.019 x 0.025-in SS archwire was used in both arches during the use of the Jasper Jumper (Fig 3).

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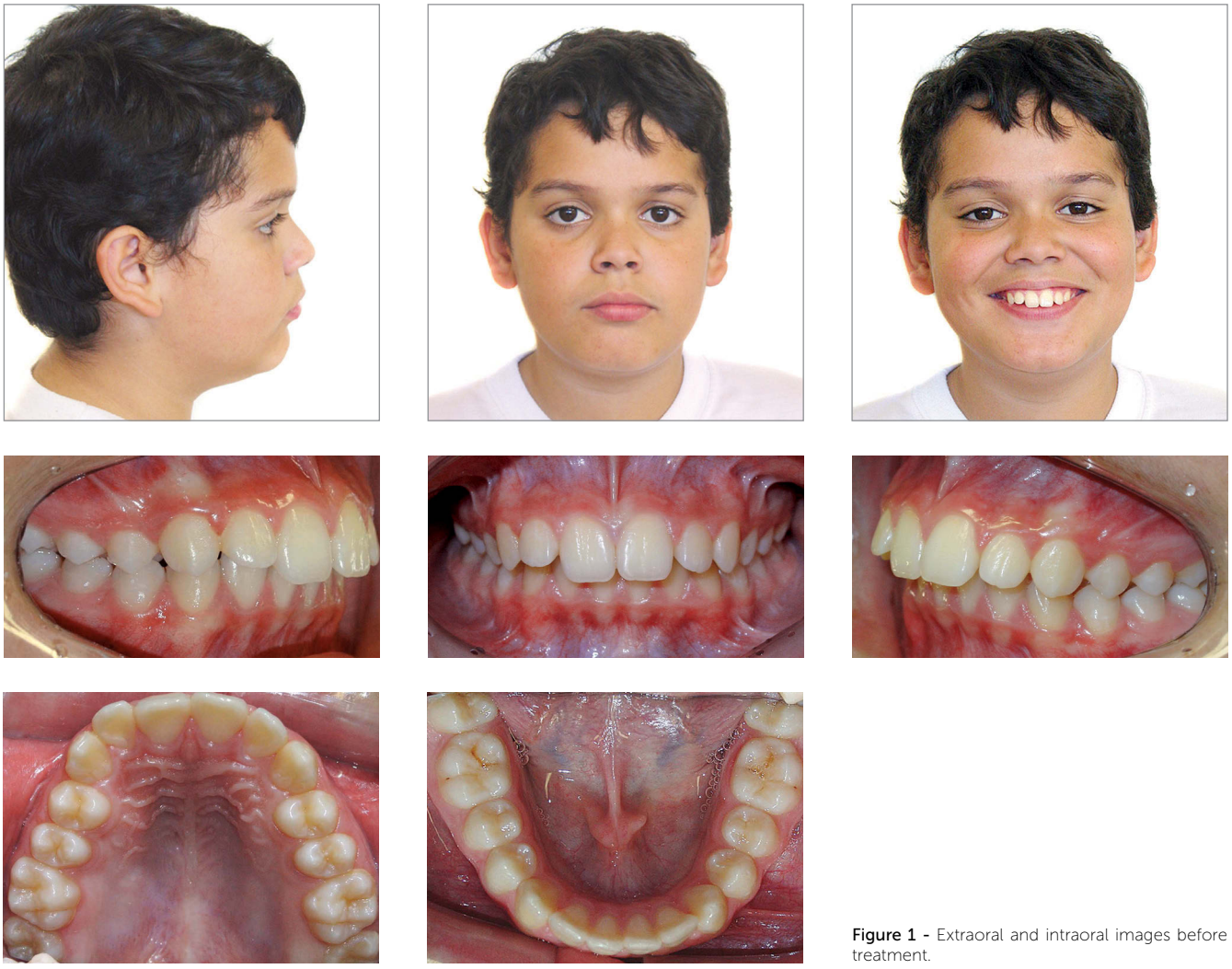


Figure 1 - Extraoral and intraoral images before treatment.

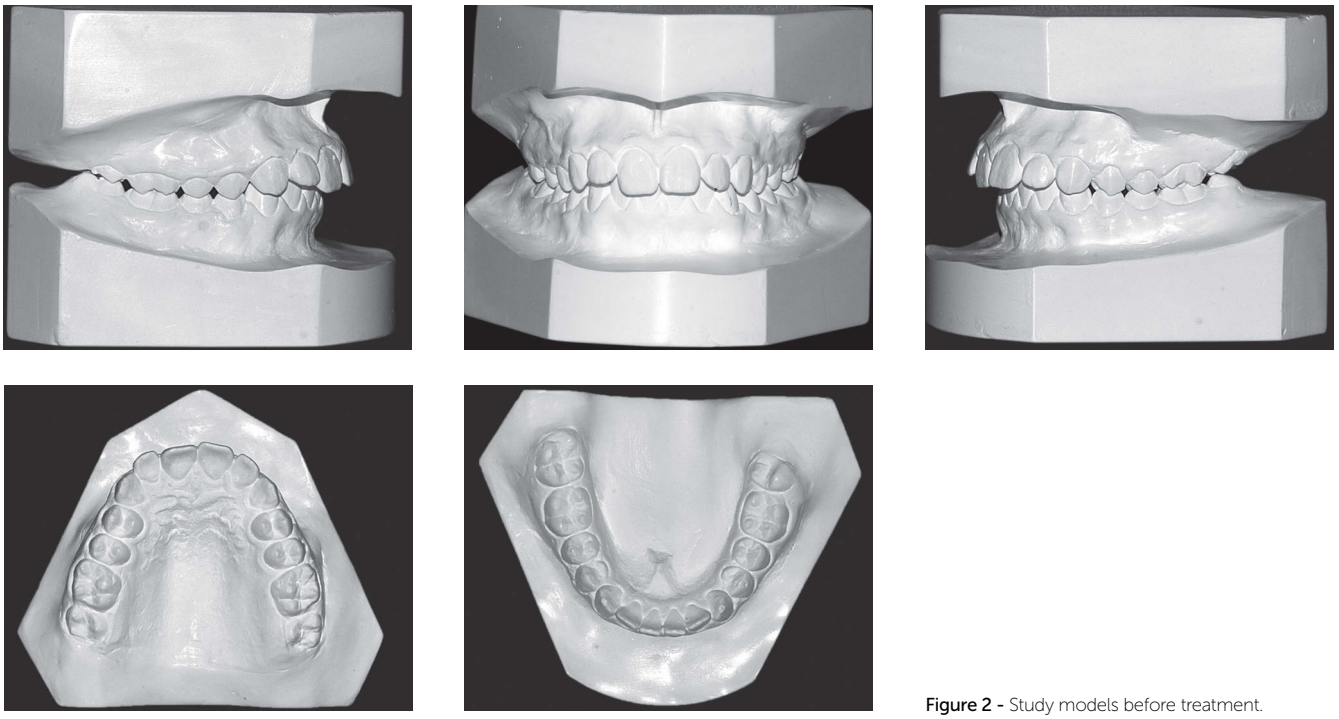


Figure 2 - Study models before treatment.

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The patient was seen every four weeks and the Jasper Jumper activated every eight weeks. The Jasper Jumper was removed when the molar and canines reached a Class I relationship or overcorrection (Figs 4 and 5). The treatment period with the Jasper Jumper was six months. After Jumpers removal, the teeth were retained with 3/16-in Class II elastics for a mean period of four months.

The centric occlusal relationship was checked and it was coincident to the centric occlusion. After debonding, a Hawley retainer was used during the day on the upper arch and a modified Bionator at night during one year. Also, a 3 x 3 lower fixed retainer was used until the end of craniofacial growth (Figs 5, 6 and 7)

RESULTS

The treatment with the Jasper Jumper improved the patient's profile as well as the overjet, overbite and molar relationship. However, it caused clockwise mandibular rotation and increase of lower anterior facial height. The lower incisors were protruded and extruded and the lower molars were extruded.

DISCUSSION

A favorable improvement of the facial profile (Table 1), shows that the Jasper Jumper had a positive effect. As the upper incisors retruded, the upper lip retracted and ceased the interference of the lower lip with the upper incisors. Apart from this, the flaring of the lower incisors gave support to the lower lip. The lip length reduced favorably, due to the retrusion of the upper incisors. Previous studies showed similar soft tissue changes.[8,13]

The mechanism of the Jasper Jumper appliance consists in forward orthodontic force on the mandible and a backward mechanical loading on the maxilla. The effect of the latter resulted in the reduction of the effective length of the maxilla (Co-A). This was the only skeletal change caused by the appliance. This finding agrees with the results of other investigators that reported that the Jasper Jumper had a headgear effect on the maxilla. These effects were expected according to previous studies,[4] but as shown in several studies and in this clinical case, the orthodontic effects are more expressed than the orthopedic. At the same time, the Jumper exerts an intrusive force on the anterior portion of the lower dentition and on the posterior portion



Figure 3 - After alignment and leveling with fixed appliances – Installation of Jasper Jumper and mandibular advancement.

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Figure 4 - Extraoral and intraoral images after treatment.

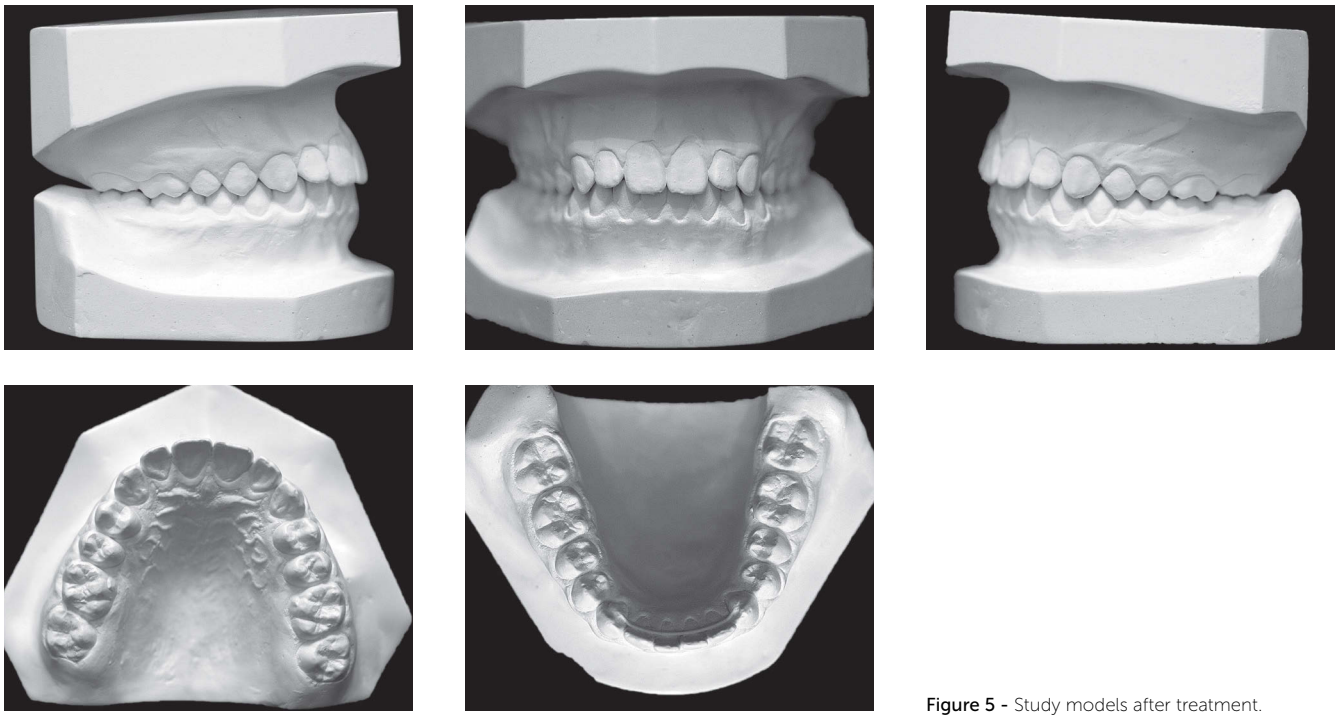


Figure 5 - Study models after treatment.

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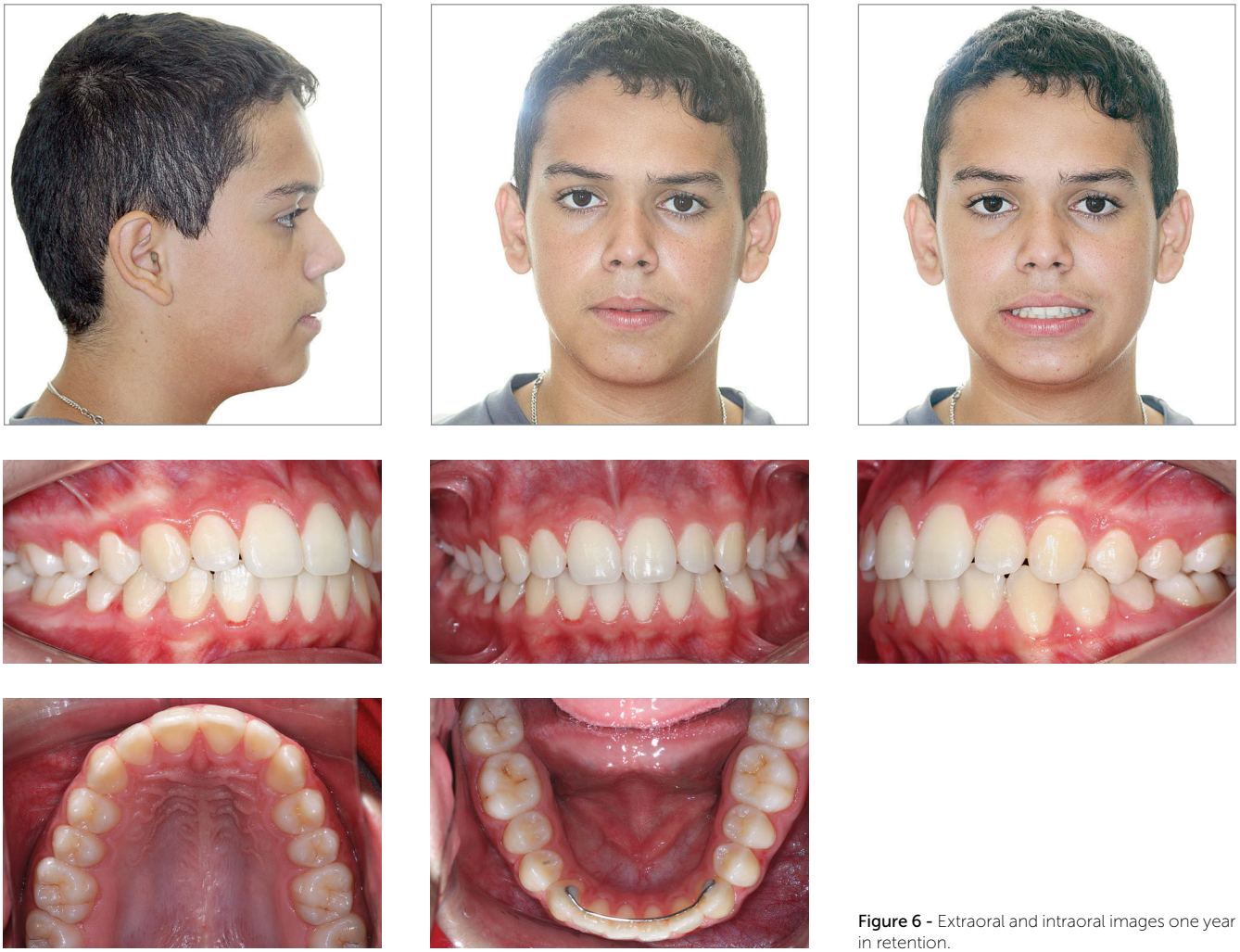


Figure 6 - Extraoral and intraoral images one year in retention.

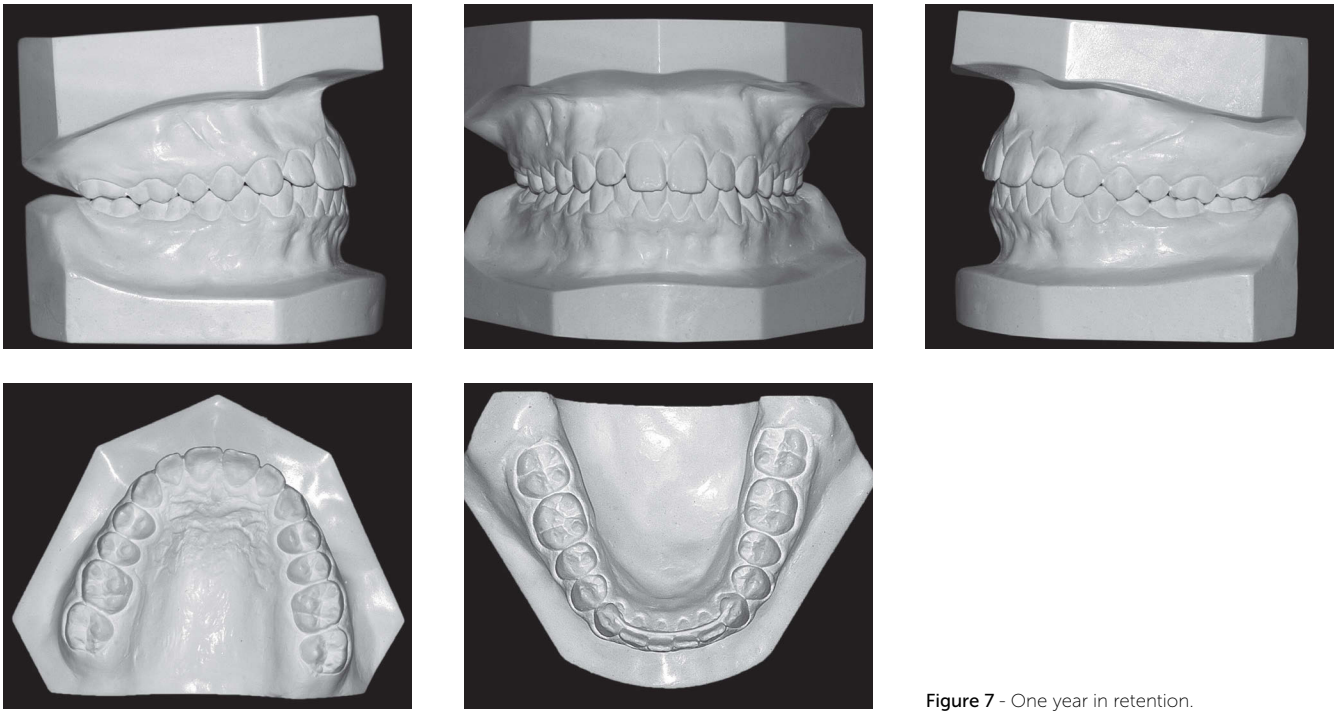


Figure 7 - One year in retention.

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Table 1 - Changes in cephalometric variables during and after treatment.

Skeletal variables			
Maxillary			
	Pretreatment	Post-treatment	Retention
SNA	82.2	78.9	78.9
Co-A	81.4	80	80
A-NPerp	3.3	1.5	1.6
Mandibular			
	Pretreatment	Post-treatment	Retention
SNB	77.4	76.6	76.7
Co-Gn	106.9	109.1	109.6
P-NPerp	-0.4	-5.7	-5.8
Maxillomandibular			
	Pretreatment	Post-treatment	Retention
ANB	4.8	2.2	2.2
NAP	8.2	2.9	2.9
Growing			
	Pretreatment	Post-treatment	Retention
SN.GoGn	38.1	39.2	39.1
Sn.PP	7.4	6.1	6.2
LAFH	62.9	67.9	68
Dentoalveolar variables			
Maxillary			
	Pretreatment	Post-treatment	Retention
1.PP	114.6	118.4	118.5
1.NA	25	33.4	33.5
1-NA	5.4	8.9	9.0
1-ENAperp	-2.4	-2.2	-2.2
1-PP	28.6	29.7	29.8
6-PP	20.9	22.3	22.6
6-ENAperp	-28.6	-30.9	-30.8
Mandibular			
	Pretreatment	Post-treatment	Retention
1.NB	28.3	34.7	34.8
1-NB	5.3	8.8	8.8
1-Pogperp	-11.4	-7.4	-7.5
1-GoMe	38.1	39.6	39.8
6-Pogperp	-30.0	-28.9	-28.8
6-GoMe	26.4	29.4	29.5
Dental Relation			
	Pretreatment	Post-treatment	Retention
Molar relation	-1.4	2.5	2.5
Overjet	6.0	2.9	3.0
Overbite	5.2	0.8	1.0
Soft tissues			
	Pretreatment	Post-treatment	Retention
NLA	105.0	108.2	110.0
UL-E	0.7	2.7	2.6
LL-E	-1.6	-1.8	-1.6

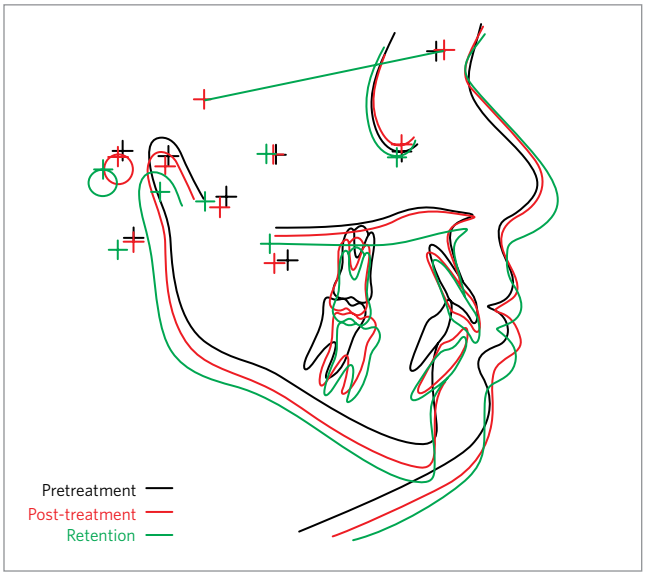


Figure 8 - Cephalometric tracings superimposition: pretreatment (black); post-treatment (red); retention (green).

of the upper dentition. The intrusive force resulted in intrusion of mandibular incisors and upper first molars (1-GoMe and 6-PP) on Table 1. The ANB angle reduced 2.6 degrees. The intrusion of the upper molars and lower incisors caused the functional inclination of the occlusal plane. The lower anterior and total facial height increased from 62.9 to 67.9 mm when the Jasper Jumper was used and remained constant one year later. The smallest reduction on the anteroposterior mandibular position in relation to the cranial base (SNB), -1.2 degrees during the treatment, can be attributed to the clockwise mandibular rotation, as found in previous studies.[4] On the other hand, no skeletal effects were found on mandibular growth. Our results agree with the findings of Cope et al,[4] Küçükkeles and Orgun,[8] but it contradicts Weiland et al.[13] There was a slight mandibular posterior rotation due to extrusion of lower molars (SN.GoGn). In addition to the vertical movement, the lower molars also moved mesially and the upper molars distally, assisting the dentoalveolar Class II correction. The upper incisors uprighted 12.4 degrees in relation to SN, although the lower incisors tended to flare. In this case, the lower incisor angle with line NB increased 6.4 degrees, when added to the upper incisor movement, contributed to most of the reduction of the excessive overjet. The patient was seen one year after treatment and the results were very satisfying (Figs 6, 7 and 8). The overjet and overbite were correct and remained stable one year after the treatment.

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CONCLUSION

The Jasper Jumper appliance is an alternative treatment for Class II malocclusion in the permanent dentition in non-cooperative patients correcting this malocclusion through more dentoalveolar than skeletal effects. The only skeletal effect is the restricted growth of the maxilla, but with no significant variations on craniofacial growth standard, although a slight posterior rotation of the mandible occurs. Dental changes, as the protrusion of lower incisors and the uprighting of upper incisors are positive for the correction of Class II malocclusion. The dental relation (overjet, overbite and molar relation) is improved with this individualized treatment.

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Sagittal and vertical aspects of Class II division 1 subjects according to the respiratory pattern

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Introduction: The teeth position, specially maxillary and mandibular incisors, in relation to basal bone and surrounding soft tissues must be considered in the elaboration of diagnosis, treatment planning and execution to obtain alignment, leveling, intercuspation, facial balance and harmony with stability of results.

Objectives: To evaluate the modifications in the positioning of incisors in individuals with Angle Class II, division 1 malocclusion in two distinct moments of dentocraniofacial development, with mean interval of 2 years and 5 months.

Methods: The measures were obtained by means of lateral cephalograms of 40 individuals, being 23 nasal breathers (NB) and 17 mouth breathers (MB). The analyzed measures were overjet, overbite, UCI-NA, LCI-NB, UCI.NA, LCI.NB, UCI.SN, LCI.GoGn, UCI.LCI, ANB, GoGn.SN, and OccPl.SN. Statistical analysis (2-way repeated-measures ANOVA) was applied to verify intergroups differences.

Results: Overjet, UCI-NA, LCI-NB, ANB, GoGn.SN, and OccPl.SN demonstrated statistically significant difference ($p < 0.05$) when observed the moment or the respiratory method.

Conclusion: There is alteration in the positioning of incisors during growth with interference of the respiratory pattern.

Keywords: Angle Class II malocclusion. Mouth breathing. Breathing. Vertical dimension.

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INTRODUCTION

Overbite is the vertical trespass and overjet is the horizontal trespass, which suffer significant alterations during development of dentition, from initial mixed dentition to permanent occlusion.[16] Overbite is correlated to other measures that indicate facial dimensions, such as mandibular plane and occlusal plane angles. Overjet usually is a reflex of the anteroposterior skeletal relation,[8] and it is sensible to the atypical function of lips and tongue. On the development of Class II and III malocclusions, these dental measurements tend to adapt to abnormal skeletal relations. The position of maxillary and mandibular incisors, the relation between both and to the surrounding tissues, are important characteristics in the diagnosis, execution and stability of the treatment. The measures related to positioning of incisors affect the balance and harmony of facial profile. Due to its importance, since the introduction of craniometry, the position of mandibular incisor on sagittal plane became a precious tool to assess a malocclusion.[3,7] The determination of positioning of maxillary and mandibular incisor is part of most cephalometric analysis.[4] Downs[6] and Riedel[19] advocated specific values for the position of mandibular incisor, however, other values were suggested and used to predict the stability of the treatment results.[22,25,26] The maxillary incisors perform an important role because they provide the inclination for protrusive mandibular movement.[20] Also, the position and specially the axial inclination of maxillary and mandibular incisors, are determinative on facial esthetics, as incisors with increased axial inclinations, create protruded lips and, many times, absence of passive lip seal. The orthodontic treatment is frequently performed during adolescence, between 10 and 16 years of age.[17] Consequently, the evaluation of incisors positioning, its relation to adjacent structures, overjet and overbite during this period may provide information and contribute to the elaboration of diagnosis, planning, treatment and assessment of the post treatment stability. Thus, this work aims to assess the alterations on the position of maxillary and mandibular incisors in individuals with Angle Class II malocclusion,division 1, in two distinct moments of the dentocraniofacial development, with mean interval of 2 years and 5 months according to respiratory pattern.

MATERIAL AND METHODS

To perform this research it was used lateral cephalograms of 40 individuals with Angle Class II division 1 malocclusion, where 23 were nasal breathers (NB) and 17 mouth breathers (MB), aged between 10 years and 9 months and 14 years (T_1), and between 13 years and 4 months and 16 years and 6 months (T_2). The classification of respiratory pattern was done according to protocol described by Wieler et al,[27] which includes clinical evaluation of lip seal performed by dental surgeon, survey answered by the parents regarding respiratory habits, otorhinolaryngological assessment and speech evaluation. From these evaluations it was assigned scores and weighting for each evaluation, creating an index to classify the individual's predominant respiratory pattern. On each cephalogram it was fixed a sheet of acetate paper, 50 μm thick and 18 cm high x 17 cm wide. The cephalograms were traced with mechanical pencil Pentel P203 and graphite 2B, 0,3 mm of diameter, considering the interesting anatomic structures, and only on the left side, by a single operator, in a darkened room, being the only source of light the one from the negatoscope. The linear measures were performed with a single ruler with precision of 0.5 mm, and the angular measures with a protractor, precision of 0.5 degrees. The used angular and linear measures were the following, showed in Figure 1:

1. Overjet: Distance from vestibular surface of mandibular central incisor to palatine surface of maxillary central incisor, in millimeters.
2. Overbite: Distance, in millimeters, that the maxillary central incisor trespass the mandibular central incisor.
3. UCI-NA: Distance, in millimeters, from the vestibular surface of maxillary central incisor to the NA line.
4. LCI-NB: Distance, in millimeters, from the vestibular surface of mandibular central incisor to the NB line.
5. UCI.NA: Angle, measured in degrees, formed by the intersection of the long axis of maxillary central incisor and the NA line.
6. LCI.NB: Angle, measured in degrees, formed by the intersection of the long axis of mandibular central incisor and the NB line.
7. UCI.SN: Angle, measured in degrees, formed by the intersection of the long axis of maxillary central incisor and the SN line.

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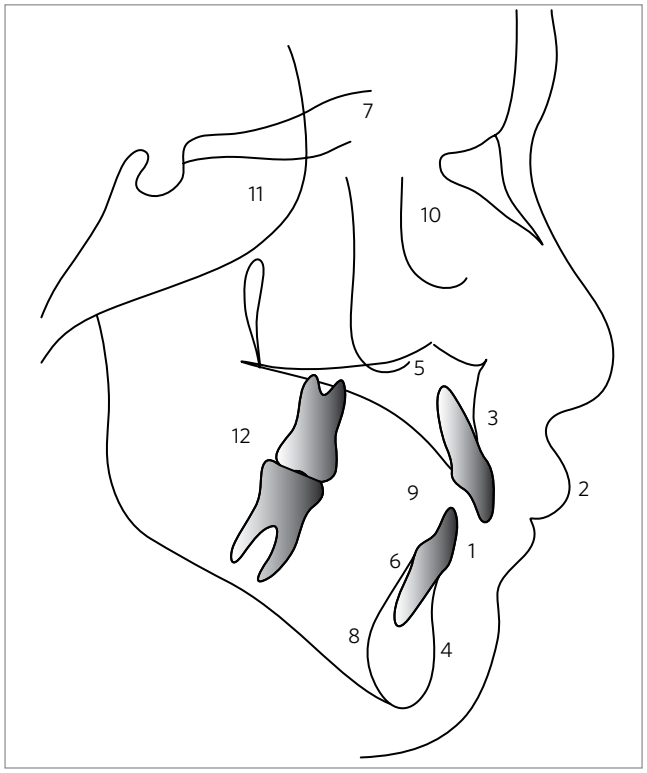


Figure 1 - Linear and angular measurements used.

8. LCI.GoGn: Angle, measured in degrees, formed by the intersection of the long axis of mandibular central incisor and the mandibular plane.
9. UCI.LCI: Angle, measured in degrees, formed by the intersection of the long axis of maxillary central incisor and the long axis of mandibular central incisor.
10. ANB: Difference, measured in degrees, between the angles SNA and SNB, determines the position of the maxilla and mandible in the anteroposterior direction.
11. GoGn.SN: Angle, measured in degrees, that determines the facial pattern in vertical direction.
12. OccPl.SN: Angle, measured in degrees, that determines the inclination of occlusal plane in relation to SN line.

STUDY'S REPRODUCIBILITY ERROR

To evaluate the reproducibility error, it was randomly selected 30 teleradiographs and a single operator performed the cephalometric evaluation for the second time, with interval of 30 days. It was calculated the systematic error[5] between the two evaluations and it was observed that, for all the studied measures, this did not exceed 3%, thus obtaining reliability for all obtained data.

RESULTS

The statistical analysis was performed using the Statistical Package for the Social Science 15.0 for Windows (SPSS, Inc., Chicago, IL, USA). The verification of normality was performed through Kolmogorov-Smirnov test, at significance level of 0.05. Once it was found the normal distribution, the verification of existence or absence of difference between the means (Table 1) of the two types of breathers for each one of the two moments, was performed with the aid of ANOVA with two criteria for classification, with repeated measures.

When ANOVA demonstrated that there was a statistically significant difference ($p < 0.05$) between the mean values of overjet, UCI-NA, LCI-NB, ANB, GoGn.SN and OccPl.SN according to moment or respiratory pattern, it was used Tukey's HSD test of multiple comparison to identify which groups were different from one another (Table 2).

DISCUSSION

The results of the present work showed that there were alterations on the measures related to positioning of incisors according to moments and respiratory pattern, agreeing with Ceylan et al.[4] It was observed reduction of the overjet from T_1 to T_2 in both analyzed groups of individuals (nasal and mouth breathers). This behavior occurs because of the mandibular growth that tends to reduce the facial convexity and the overjet, according to proved studies by Ceylan et al.[4] Besides, the modification in the positioning of incisors may also have caused the reduction of overjet, for the measure LCI-NB increased in larger proportion than the UCI-NA. Another factor to be considered, is the reduction of the occlusal plane, probably caused by the counterclockwise rotation of the mandible, and consequently reduction of overjet. It is emphasized that the respiratory pattern affected this measure, since mouth breathers present greater overjet than nasal breathers, according to Mocellin[15] and Ricketts,[18] who point the respiratory pattern as an etiologic factor for malocclusions. Generally, mouth breathing patients tend to present a protruded maxilla and maxillary atresia, consequence of the alteration on the tongue position, which becomes lower, breaking the

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Table 1 - Mean and standard deviation of linear and angular measures.

MEASURE	GROUP	n	MEAN	S.D.	MEASURE	GROUP	n	MEAN	S.D.
Overjet	NB T_1	23	4.21	2.14	UCI.SN	NB T_1	23	75.96	5.18
	NB T_2	23	3.74	1.77		NB T_2	23	74.96	5.53
	MB T_1	17	5.35	1.86		MB T_1	17	75.71	5.82
	MB T_2	17	5	1.7		MB T_2	17	74.59	5.29
Overbite	NB T_1	23	3.26	2.18	LCI.GoGn	NB T_1	23	98.78	4.23
	NB T_2	23	3.35	1.7		NB T_2	23	99.09	4.33
	MB T_1	17	3.15	2.26		MB T_1	17	99.29	4.81
	MB T_2	17	3.38	1.98		MB T_2	17	99.53	5.52
UCI-NA	NB T_1	23	5.28	1.66	UCI.LCI	NB T_1	23	125.7	7.5
	NB T_2	23	5.85	1.84		NB T_2	23	124.61	7.59
	MB T_1	17	5.56	1.69		MB T_1	17	121.41	6.44
	MB T_2	17	5.71	1.93		MB T_2	17	120.82	7.35
LCI-NB	NB T_1	23	5.61	1.8	ANB	NB T_1	23	4.48	2.19
	NB T_2	23	6.13	1.53		NB T_2	23	4	2.15
	MB T_1	17	6.97	1.75		MB T_1	17	5.94	1.68
	MB T_2	17	7.15	1.82		MB T_2	17	5.24	1.56
UCI.NA	NB T_1	23	22.22	4.78	GoGn.SN	NB T_1	23	31.83	5.1
	NB T_2	23	22.83	5.27		NB T_2	23	30.7	5.09
	MB T_1	17	22.88	6.5		MB T_1	17	34.71	4.04
	MB T_2	17	23.82	6.43		MB T_2	17	33.71	4.57
LCI.NB	NB T_1	23	28.09	4.94	OccPl.SN	NB T_1	23	16.48	4.83
	NB T_2	23	27.87	4.88		NB T_2	23	14.83	5.21
	MB T_1	17	29.59	4.09		MB T_1	17	19.12	2.26
	MB T_2	17	29.76	5.52		MB T_2	17	17.53	2.21

Table 2 - Mean, standard deviation and p value for the variables.

MEASURE	GROUP	n	MEAN	S.D.	intra and Intergroups difference
Overjet	NB T_1	23	4.21	2.14	NS
	NB T_2	23	3.74	1.77	*NB T_2 X MB T_1
	MB T_1	17	5.35	1.86	*NB T_2 X MB T_1
	MB T_2	17	5	1.7	NS
UCI-NA	NB T_1	23	5.28	1.66	*NB T_1 X NB T_2
	NB T_2	23	5.85	1.84	*NB T_1 X NB T_2
	MB T_1	17	5.56	1.69	NS
	MB T_2	17	5.71	1.93	NS
LCI-NB	NB T_1	23	5.61	1.8	*NB T_1 X NB T_2, *NB T_1 X MB T_2
	NB T_2	23	6.13	1.53	*NB T_1 X NB T_2
	MB T_1	17	6.97	1.75	NS
	MB T_2	17	7.15	1.82	*NB T_1 X MB T_2
ANB	NB T_1	23	4.48	2.19	NS
	NB T_2	23	4	2.15	**NB T_2 X MB T_1
	MB T_1	17	5.94	1.68	**NB T_2 X MB T_1
	MB T_2	17	5.24	1.56	NS
GoGn.SN	NB T_1	23	31.83	5.1	**NB T_1 X NB T_2
	NB T_2	23	30.7	5.09	**NB T_1 X NB T_2
	MB T_1	17	34.71	4.04	NS
	MB T_2	17	33.71	4.57	NS
OccPl.SN	NB T_1	23	16.48	4.83	***NB T_1 X NB T_2
	NB T_2	23	14.83	5.21	***NB T_1 X NB T_2, ***NB T_2 X MB T_1
	MB T_1	17	19.12	2.26	***NB T_2 X MB T_1
	MB T_2	17	17.53	2.21	NS

NOTE: Significance level for Tukey HSD multiple comparisons *p < 0.05; **p < 0.03; ***p < 0.01.

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balance with the buccinator muscle. It was verified an increase of the linear measures UCI-NA and LCI-NB from 10 to 16 years of age, which may be related to projection of maxillary and mandibular incisors, agreeing with Bishara.[2] On the other hand, Forsberg[9] observed verticalization of the incisors with facial growth. In this research, the measurement LCI-NB presented an increase proportionally larger than UCI-NA, explained as a way to camouflage the Class II skeletal relation. It is suggested that the alteration observed in the positioning of incisors can also be explained by the action of tongue muscles. However, Baydas et al[1] did not observe statistically significant difference in the positioning of these teeth during growth. From analysis of the ANB angle it was verified that there was a reduction on the difference between maxillary and mandibular bone bases in the sagittal plane, which seems to be directly related to mandibular growth and overjet alterations. The fact that the linear measurements related to the positioning of the mandibular incisor increases in larger proportion than the maxillary incisor may have caused the reduction on ANB. The respiratory pattern affected this result, where mouth breathers presented a larger ANB, disagreeing with the results of Frasson et al.[10] It is suggested that the decline on the tongue rest position, affected the maxillary growth, according to Subtelny[23] nasal breathing is essential for a correct growth and development of the craniofacial complex. However, Jakobsone et al[12] advocate that the respiratory pattern does not affect the soft tissue profile, and that such changes depend of the craniocervical posture and age of the patients. The angular measurement GoGn.SN presented a reduction from initial to final moment. It is concluded that this reduction can be related to counterclockwise mandibular rotation, as consequent reduction of overjet and ANB, as occurred in this work. The facial growth pattern is also responsible for alterations in this measure, for individuals with tendency to horizontal growth, will present a reduced GoGn.SN, and individuals with vertical growth, an increased GoGn.SN. As all patients were in growth stage, the difference can be explained by a genetic horizontal growth pattern disagreeing with results of Lessa et al,[14] which did not observe significant differences on these measures. Likewise, the measure OccPl.SN also reduced, due to reduction on the inclination of occlusal plane, consequence of the change on positioning of maxillary and mandibular incisors and the mandibular rotation. This measurement was affected by the respiratory pattern, according to Lessa et al,[14] mouth breathers present greater mandibular inclination and vertical growth pattern. This work obtained statistically significant differences in the positioning of incisors in individuals with distinct respiratory patterns, agreeing with results by Spinelli.[21] Thus, the mouth breathing affected growth of some facial structures, causing a mandibular rotation down and backwards, in relation to the palate; and reduction of angle formed by intersection of mandibular plane with nasal plane.[13] According to literature, there is correlation between alterations caused by mouth breathing and the occlusion,[13] fact also verified in this work. It is assumed that alterations occurred on measures were consequence of genetic growth pattern, for with aging there is a tendency of the facial profile to become relatively more straight[28] associated to environmental factors, especially the respiratory method. However, this result disagree with Gwynne-Evans and Ballard;[11] Tomer and Harvold,[24] which indicated that muscle patterns and skeletal growth are genetically defined and, therefore, the individual characteristics, favorable or not, are inherited and little influenced by the alterations on respiratory pattern. Therefore, the alterations in positioning of incisors and the individual's respiratory pattern must be considered on the diagnosis, elaboration of treatment plan and execution of treatment in individuals in growth stage.

CONCLUSION

It is concluded that there was alteration in the positioning of incisors and overjet, during growth and with interference on the respiratory pattern.

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Morphological evaluation of the active tip of six types of orthodontic mini-implants

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Objective: To morphologically evaluate the active tip of six different types of self-drilling mini-implants for orthodontic anchorage.

Methods: Images of the active tips of the mini-implants were obtained with a Zeiss optical microscope, Stemi 200-C with magnification of 1.6X. The images of the surface were viewed with the Axio Vision program (Zeiss, Jena, Germany) to calculate linear and angular measures. Mini-implant morphology and the details of tips and threads were also evaluated through Scanning Electronic Microscopy (SEM) (JEOL, model JSM5800 LV – JEOL, Tokyo, Japan) with magnifications of 90X and 70X, respectively. The evaluation of the mini-implant taper shape was assessed using to the formula: (b - a) / (2 x D).

Results: The following variables were measured: (1) active tip width, (2) major diameter of external thread, (3) minor diameter of internal thread and taper of the mini-implant, (4) number of threads and lead of the screw, (5) angle of thread, (6) flank width and (7) pitch width.

Conclusion: Mini-implants from different manufacturers presented active tips with different characteristics. Mechanical testing is necessary to correlate the analyzed characteristics aiming to determine the best performance.

Keywords: Orthodontic anchorage procedures. Morphology. Orthodontics.

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INTRODUCTION

Anchorage control is a decisive factor for the success of determined orthodontic treatments and for this reason, efforts have been made to develop appropriate anchorage methods. All intraoral appliances show some anchorage loss and extraoral appliances depend on patient cooperation.[22] The mini-implants introduced new possibilities of effective anchorage in orthodontics.[15,16] The installation of the mini-implant is relatively simple and, due to its reduced size, it presents possibility of insertion in several sites such as palate, retromolar area, maxillary tuberosity and between the roots on the cortical bone of the posterior and anterior regions, both by lingual or buccal.[6,7,11,12,16,22] Loading of the mini-implant can be performed immediately after installation, because retention is mostly mechanical.[5,8] Primary stability is intrinsically related to bone support, design and type of insertion of the mini-implant.[25] Mini-implants present three distinct parts: 1) the head, for installation of elastics, wires or NiTi springs; 2) Transmucosal profile or neck, region between the head and the screwable portion of the mini-implant responsible for maintenance of the health of peri-implant tissues; and 3) body or active tip of the mini-implant, which is inserted into the bone.[19,24] Mini-implant shape must offer mechanical anchorage by the contact area between implant and bone, allowing force distribution without damaging bone tissue physiology. The design must also limit surgical trauma at the moment of insertion and allow a good primary stability.[4] The cone-shaped screw assures the effect of bone condensation, improving quality and preventing from unwanted destruction of cortical bone, caused by eccentric insertion or change of axis during insertion, in other words, implant stability is not very affected by the ability of the operator or the insertion area.[23] Mini-implants vary with the most different characteristics such as diameter, width, quantity and angulation of threads and a conical or cylindrical profile.[9] Under microscopic observation, these differences are found mainly in relation to the number and proximity of the screw threads.[20] Possibly, more threads enhance resistance to displacement and primary stability.[1,24] The shape of the mini-implant must be considered when evaluating the mechanical resistance of this device,[20] as well as the available space in the insertion area and the choice of the mini-implant diameter. Smaller diameter of the screws makes the insertion between the roots easier, reducing the risk of root contact[17] and providing a reduced insertion torque.[13] The use of mini-implants with a diameter that is too large, in order to obtain a greater bone contact may cause risk of microfracture of the bone inside the threads and obstruction of the circulation, that may induce bone necrosis. On the other hand, a mini-implant with a diameter that is too small may fracture because of the friction with the bone, especially in the mandible.[10] When there is cortical bone enough to stabilize the mini-implant, 1.5 mm in diameter is enough for both maxilla and mandible.[18] To prevent injuries to the root of the adjacent teeth, the tip of the screwable portion must be narrow, facilitating the insertion and minimizing surgical trauma.[23] Depending on bone quality of the area, the ideal combination of type, diameter and width of the mini-implant indicates the site to be used.[25] The conic screws present the higher values of insertion torque, however no correlation was found between mini-implant design and the pull-out force.[13] The reduced dimensions increase the possibility of deformation of the mini-implant during its use or fracture at the moment of insertion or removal, which may be related to excessive pressure applied to the manual driver or to the use of the handpiece with torque superior to 10 Ncm.[3,14,16] The use of orthodontic mini-implants is increasing in clinical practice, because of controlled tooth movement in cases of difficult solution, however, they are offered with different physical characteristics as reasons given by the manufacturers for best clinical performance. The purpose of this work was to morphologically evaluate six different types of self-drilling mini-implants available in the market, analyzing the following characteristics: 1) active tip width, 2) major diameter of external thread, 3) minor diameter of internal thread and taper of the mini-implant, 4) number of threads and lead of the screw, 5) angle of thread, 6) flank width and 7) pitch width.

MATERIAL AND METHODS

Orthodontic self-drilling mini-implants from six different manufacturers with similar dimensional characteristics were used according to Table 1.

Mini-implant morphology evaluation

The morphology of the active part of the mini-implants was evaluated and identified by an observer calibrated and trained, by means of images obtained through

the Zeiss optical microscope, Stemi 2000-C (Zeiss, Jena, Germany) with magnification of 1.6X. The surface images were analyzed with the Axio vision program (Zeiss, Jena, Germany) to calculate the linear and angular measures (Figs 1 and 2). The mini-implant morphology and the details of the tips and of the mini-implant were evaluated through a scanning electronical microscope (SEM) (JEOL, model JSM-5800 LV - JEOL, Tokyo, Japan) with magnification of 90X and 70X respectively. The evaluation of the mini-implant taper was calculated according to the formula: (b - a) / (2 x D) = mini-implant taper (Fig 3). The mini-implant shank is considered as its external diameter excluding the thread width.

RESULTS

The linear (μm) and angular (degrees) measures of a mini-implant from each group are displayed on Table 2. The measures that present increasing relation from the neck to tip are shown in italic. The measure corresponding to the lead, angle of thread, flank width and pitch width correspond to mean value.

The images obtained on the SEM of the mini-implant, the details of the screw and the tip of the six types of mini-implants are displayed on Figures 4, 5 and 6.

DISCUSSION

The anchorage mechanism of the mini-implants is based on mechanical retention of the metallic structure on the cortical and dense bone and not necessarily on the concept of osseointegration. The shape and width of the screws are fundamental for its fixation.[2,5,8] More threads represents more resistance to displacement and greater primary stability.[1,2] In this context, characteristics such as active tip width, major diameter of external thread, minor diameter of internal thread, number of threads, pitch, thread angle, flank width, pitch width, mini-implant taper and percentage of the internal diameter in relation

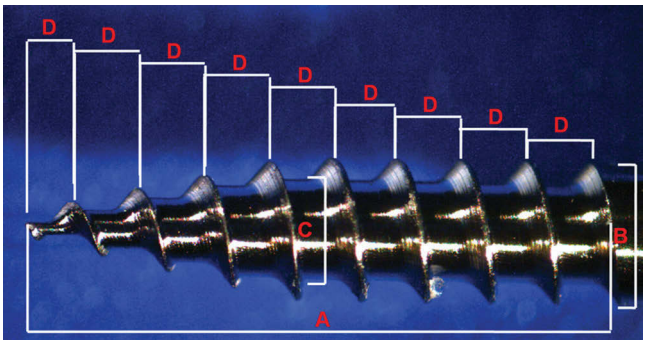


Figure 1 - **A**) Total width of the active tip; **B**) external diameter of the mini-implant; **C**) internal diameter of the mini-implant; **D**) number of threads and pitch of the screws.

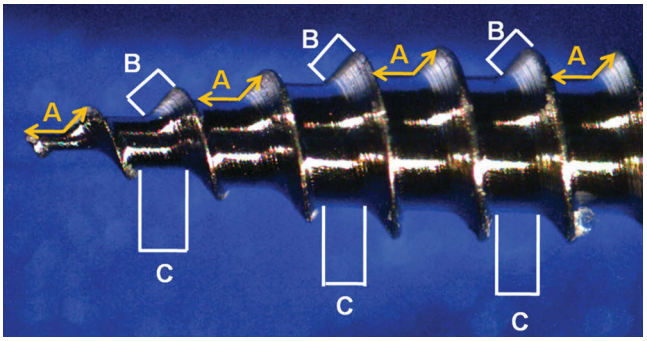


Figure 2 - **A**) Thread angle; **B**) flank width of the screw; **C**) pitch width.

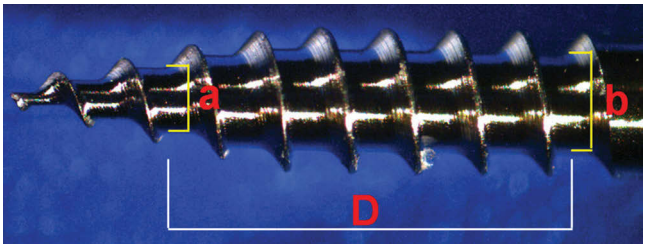


Figure 3 - Measurement of the mini-implant taper = (b - a) / (2 x D).

Table 1 - Mini-implants used: Commercial name, manufacturer, origin, diameter, total width and transmucosal profile width according to information given by the manufacturer, as well as the acronym adopted in this study.

Commercial Name	Manufacturer	Origin	Diameter	Width	Transmucosal prof.	Acronym
Tomas	Dentaurum	Ispringen Germany	1.6 mm	6 mm	Not informed	DEN
Dual-top Anchor System	Rocky Mountain Orthodontics	Korea	1.6 mm	6 mm	Not informed	RMO
Orthoimplant	Conexão	Brazil	1.5 mm	6 mm	1 mm	CON
Implant for orthodontic anchorage	Neodent	Brazil	1.6 mm	7 mm	1 mm	NEO
Orthodontic screw Wire Dynamic	SIN - Sistema de Implantes Nacional	Brazil	1.6 mm	6 mm	1 mm	SIN
AbsoAnchor	Dentos	Korea	1.6 mm	6 mm	Not informed	ABS

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Table 2 - Values of the linear and angular measures of the mini-implants for each group.

EVALUATED CHARACTERISTIC	MANUFACTURER					
	DEN	RMO	CON	NEO	SIN	ABS
Active tip width (µm)	6006.01	5329.59	5926.47	6812.51	6090.93	5079.57
Major diameter of external thread (µm)	1607.96	1539.77	1482.95	1630.72	1562.59	1607.99
Minor diameter of internal thread (µm)	1079.55	1028.42	772.75	1107.97	1164.77	1113.65
Number of threads (µm)	6	7	12	9	7	7
Pitch (µm)	**888.09**	735.39	464.49	732.32	756.49	688.31
Angle of thread (degrees)	140.22	137.69	128.85	135.31	128.46	123.16
Flank (µm)	**381.96**	**384.78**	232.11	360.58	292.79	**399.5**
Pitch width (µm)	**395.63**	327.65	239.77	323.86	376.89	327.65
Mini-implant taper	0.11	0.07	0.09	0.10	0.10	0.09
Percentage of the shank in relation to external diameter	67%	67%	52%	68%	75%	69%

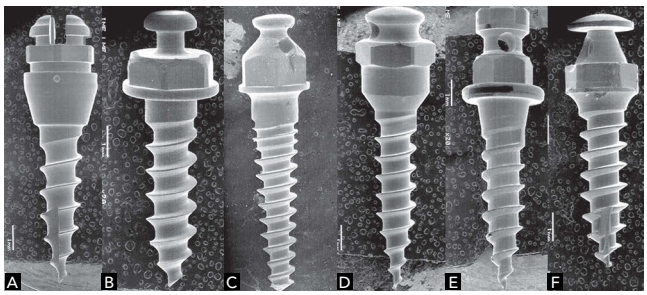


Figure 4 - Mini-implant morphology. **A**) Dentaurum; **B**) RMO; **C**) Conexão; **D**) Neodent; **E**) SIN; **F**) AbsoAnchor.

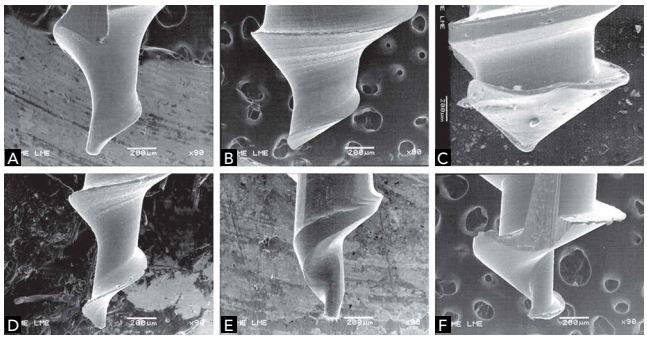


Figure 5 - Detail of the mini-implant tip, with magnification of 90X on the SEM. **A**) Dentaurum; **B**) RMO; **C**) Conexão; **D**) Neodent; **E**) SIN, **F**) AbsoAnchor.

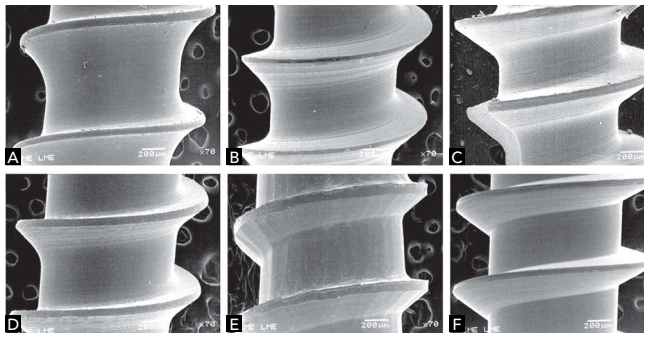


Figure 6 - Detail of the mini-implant thread, with magnification of 70X on the SEM **A**) Dentaurum; **B**) RMO; **C**) Conexão; **D**) Neodent; **E**) SIN, **F**) AbsoAnchor.

to the external diameter, are related to the mechanical properties of the mini-implants especially retention and insertion torques.

Active tip width

In relation to the active tip width, the greatest difference observed, between the information given by the manufacturer (Table 1) and the data obtained in this study (Table 2) was with the mini-implants from RMO and AbsoAnchor, while the others presented widths correspondent or very close to those informed by the manufacturer.

Mini-implant external diameter

The reduced diameter of the mini implant is an important risk factor for fracture at the moment of insertion or removal.[3,10,12,16,17] On the other hand, mini-implants with a large diameter may cause bone necrosis due to microfractures.[10] Mini-implants with a diameter smaller than 1.5 mm are more susceptible to fracture,[17] with non-significant difference in the success rates when compared to mini-implants with diameter between 1.5 and 2.3 mm.[18] The diameter of the evaluated mini-implants ranged from 1482.95 µm (Conexão) to 1630.72 µm (Neodent).

Minor diameter of internal thread

The evaluation of the mini-implant minor diameter of internal thread is another relevant risk factor for fracture, small values could mean more susceptible areas. The diameter variation ranged from 772.75 µm (Conexão) to 1164.77 µm (SIN).

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Percentage of the minor diameter of internal thread in relation to external diameter

Regarding the correlation of the external diameter and the minor diameter of internal thread of the mini-implants, Conexão presented internal diameter of 52% of the total external diameter, meaning that the internal diameter is almost half the value of the external diameter.

Number of threads

A larger amount and reduced distance between the threads may lead to greater mechanical imbrication and, consequently, greater resistance to insertion of the mini-implant to the bone.[1,20,24] Among the evaluated mini-implants, the number of screws ranged from 6 (Dentaurum) to 12 (Conexão).

Pitch

The pitch represents the distance between the threads, being intimately related to the number of threads, more threads on the mini-implant, represent smaller distance between them. The mini-implant from Conexão presented the largest amount of threads, the distance between them was also smaller (464.49 μm) and the mini-implant from Dentaurum presented the smallest amount of threads and a larger distance between them (888.09 μm).

Angle of thread

With the measurement of the angle of thread, it can be considered that a smaller angle enables greater retention of the mini-implant. In the present study, the mini-implants that presented the smallest angle of thread were AbsoAnchor (123.16°), SIN (128.46°) and Conexão (128.85°). However, reduced angles could complicate the insertion of the mini-implant, leading to high values of insertion torque, increasing the risk of fracture.

Flank width

By the evaluation of the flank width in the present study, it was possible to observe that the mini-implants from AbsoAnchor (399.5 μm), RMO (384.78 μm) and Dentaurum (381.96 μm) presented the highest mean with similar values, while those from Conexão (232.11 μm) presented the lowest mean.

Pitch width

It is directly related to the pitch of the screw. Since the mini-implant from Dentaurum presented the largest distance between the threads, it also presented the largest pitch width (395.63 μm) and those from Conexão the smallest width (239.77 μm), confirming the smaller distance between the threads.

Mini-implant taper

The design of the mini-implants was evaluated through the active tip taper. The mini-implant from Dentaurum presented the greatest taper (0.11), while the smallest taper (0.07) was found in the mini-implant from RMO. The others ranged from 0.09 to 0.10. The resistance to fracture can be increased with the conic design and with appropriate screws for self-drilling.[2] For Kwok et al,[13] conic screws present the highest values of insertion torque, although there is no correlation between the design of the mini-implant and the pullout strength. Tests of fracture to torsion and insertion torque are necessary to correlate morphological data such as diameter of the internal thread and taper of the mini-implant to the mechanical performance, assisting the clinician on the choice of the mini-implant with the morphological characteristics that most suits the clinical needs. It can be noticed from the present study that the mini-implants available on the market present active tips with different characteristics. Since this part of the mini-implant is responsible for its retention and also the most susceptible area to fracture, laboratory researches with mechanical tests must evaluate the relation of these characteristics to a better mechanical performance of the mini-implants. In this manner it will be possible to know the fundamental characteristics for the active tip of the mini-implant that allows a safe use of such devices.

CONCLUSION

Mini-implants from different manufacturers presented active tips with different characteristics.

The acquaintance of the ideal characteristics of mini-implant morphology will allow the conscious and substantiated choice for its use in several clinical application for orthodontic treatment.

Laboratory mechanical testing of insertion, removal, pullout and fracture are necessary to correlate the analyzed characteristics with the purpose of determining the best performance.

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Stability of molar relationship after non-extraction Class II malocclusion treatment

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Objective: This study aimed to evaluate the stability of molar relationship after non-extraction treatment of Class II malocclusion.

Methods: The sample comprised 39 subjects (16 females, 23 males) with initial Class II malocclusion treated with no extractions, using fixed appliances. Mean age at the beginning of treatment was 12.94 years, at the end of treatment was 15.14 years and at post-retention stage was 21.18 years. Mean treatment time was 2.19 years and mean time of post-treatment evaluation was 6.12 years. To verify the influence of the severity of initial Class II molar relationship in stability of molar relationship, the sample was divided into two groups, one presenting a ½-cusp or ¾-cusp Class II molar relationship, and the other with full-cusp Class II molar relationship. In dental casts from initial, final and post-retention stages, molar, first and second premolars and canine relationships were measured. Data obtained were analyzed by dependent ANOVA, Tukey and Pearson's correlation tests, as well as independent *t* test between the two groups divided by severity of initial molar relationship.

Results: There was a non-statistically significant 0.12 mm relapse of molar relationship. The initial severity of Class II molar relationship was not correlated to relapse in the post-retention period. When compared, the two groups showed no difference in relapse of molar relationship.

Conclusion: It was concluded that correction of Class II molar relationship is stable and initial severity does not influence relapse of molar relationship.

Keywords: Corrective orthodontics. Angle Class II malocclusion. Treatment outcomes.

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INTRODUCTION

Class II malocclusion does not self-correct in growing patients.[8,17] The Class II skeletal pattern is established early and remains until puberty if no orthodontic intervention is performed.[8]

To this date, several authors have discussed the relationship of the initial malocclusion characteristics with the effectiveness of orthodontic treatment[22,31,40] and the stability of the corrections obtained.[7,33,43]

Normally, orthodontic treatment takes a long time and uses complex techniques, usually achieving good results; however, these results may be lost in varying degrees after the removal of appliances and retainers.[38] Orthodontic relapse includes crowding or spacing of teeth, and loss of overbite, overjet correction, and loss of Class II molar relationship correction.

Orthodontic changes of the position of the first permanent molars have a great tendency to relapse.[24] Some authors affirm that Class I molar relationship is more stable compared to others and, over time, the mandibular molar tends to distalize in patients with Class II malocclusion.[17] For Uhde, Sadowsky and BeGole,[39] changes that occur in molar relationship are always towards Class II relation. The changes are of small magnitude and independent of the type of initial malocclusion and the type of treatment. Other authors suggest that, in the long-term, there is minimal relapse in molar relationship and that changes in incisor position and intercuspation of the posterior teeth are statistically significant, although not considered clinically significant.[12,39]

The stability of Class II malocclusion has been widely studied, however, few studies that have actually evaluated relapse and stability of the correction of Class II molar relationship in models. The studies are mostly directed to a particular type of appliance or treatment protocol.

In this context, the objective of this study was to evaluate the stability of molar relationship in cases with initial Class II malocclusion, treated orthodontically without extractions, correlating with factors such as the severity of initial Class II molar relationship, treatment, retention and post-retention times. Moreover, the objective was to compare the post retention stability of molar relationship between two groups divided according to the severity of the initial Class II molar relationship.

MATERIAL AND METHODS

For the present retrospective study, the sample was obtained from the records of the Department of Orthodontics, Bauru Dental School, University of São Paulo.

The inclusion criteria comprised the following characteristics:

- Angle Class II malocclusion, treated without extractions.
- Presence of erupted permanent teeth up to first molars, at the beginning of orthodontic treatment.
- Absence of tooth agenesis and supernumerary teeth.
- No anomalies in size and / or shape of the teeth.
- Absence of rotations of the maxillary and mandibular molars in the initial models, which could influence variable measurement.
- Orthodontic treatment with fixed appliances, which may include the use of headgear and / or Class II intermaxillary elastics.
- Complete orthodontic records, including study models of pre and post treatment and post retention records.

All patients in the sample were Caucasian, of both genders. The study models of the pretreatment (T_1 - initial), posttreatment (T_2 – final) and post-retention phases (T_3 - post-retention at least 2 years after the end of treatment) were used.

The sample was composed of a total of 39 patients, 16 females and 23 males. The mean age at pretreatment was 12.94 ± 1.21 years, the mean age at the end of treatment was 15.14 ± 1.38 years, and the mean age at post-retention was 21.18 ± 2.65 years. The mean treatment time was 2.19 ± 0.83 years. The mean post-treatment time evaluation, (between the final and post-retention stages) was 6.30 ± 2.60 years. At the end of active orthodontic treatment all patients used a removable Hawley plate retainer in the maxillary arch and a bonded fixed retainer from canine to canine in the mandibular arch. The retainers were used, on average, 1.62 ± 0.49 years.

To evaluate the influence of the severity of the initial Class II molar relationship in the stability of molar relationship, the sample was divided into two groups: Group 1, 16 patients presenting half-cusp or ¾-cusp initial Class II molar relationship. The mean age at

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pretreatment was 13.27 ± 1.11 years, the mean age at the end of treatment was 15.10 ± 1.35 years and the mean age at post-retention was 20.18 ± 2.03 years. The mean treatment time was 1.83 ± 0.49 years, the mean retention time was 1.58 ± 0.55 years and the mean time between posttreatment and post-retention phases was 5.29 ± 1.57 years. Group 2 consisted of 23 patients with a complete initial Class II molar relationship. The mean age at pretreatment was 12.71 ± 1.25 years, the mean age at the end of treatment was 15.17 ± 1.42 years and the mean age at post-retention was 21.87 ± 2.84 years. The mean treatment time was 2.45 ± 0.94 years, the mean retention time was 1.69 ± 0.46 years and the mean time between posttreatment and post-retention phases was 6.70 ± of 2.46 years.

The orthodontic records of the selected sample were used to obtain some relevant data for this work. Clinical records were examined for therapeutic procedures at pre and posttreatment, and the posttreatment follow-ups. The date of removal of retainers was also observed. These data, together with the patient's date of birth, allowed accurate determination of the total time of treatment, control, posttreatment, post-retention, retention time and age of the patients in the studied phases.

The study models concerning initial, final and post-retention stages of each patient were evaluated. Study models were photographed with a D-80 camera, with 105 mm close-up lens (AF-S VR Micro Nikkor 105 mm f/2.8G IF-ED, Nikon Corporation, Japan) and circular flash (Nikon Corporation, Japan) with 300 dpi (dots per inch). From each study model, two lateral photographs were obtained, one on the right side and one on the left, with the buccal surfaces of posterior teeth parallel to each other. All photographs were obtained with the same distance between the object and the lens (31.4 cm), to avoid magnification.

The digital images were inserted into a computer and analyzed with Dolphin Imaging software version 10 (Dolphin Imaging and Management Solutions, Chatsworth, CA, USA). This program magnifies each image by means of their size in dpi. For each variable, two points are marked and the distance between them was calculated by the software. The accuracy of measurements was 0.01 mm. For the statistical analysis, the mean right and left sides of each measurement was obtained. The calculated variables are presented in the following topics.

Molar relationship

The molar relationship was measured from the tip of the mesiobuccal cusp of the maxillary first molar to the mesiobuccal groove of the mandibular first molar (Fig 1). The average of right and left sides was used.

Second premolar relationship

The relationship of the second premolars was measured from the tip of the buccal cusp of the maxillary second premolar to the distal anatomical contact point between the mandibular second premolar and the mesial of the mandibular first molar (Fig 2). The average of right and left sides was used.

First premolar relationship

The relationship of first premolars was measured from the tip of the buccal cusp of the maxillary first premolar to the distal anatomical contact point of the mandibular first premolar and mesial of the mandibular second premolar (Fig 3). The average of right and left sides was used.

Canine relationship

The canine relationship was measured from the cusp tip of the maxillary canine to the anatomical contact point between the distal mandibular canine and the mesial of the mandibular first premolar (Fig 4). The average of right and left sides was used.

Statistical analysis

Method error

The intra-examiner error was evaluated by taking new measurements of the initial, final and post-retention study models of 15 patients randomly selected, performing a total of 45 pairs of models. The first and second measurements were performed with a time interval of one month. The formula proposed by Dahlberg[11] ($Se^2 = \Sigma d^2/2n$) was applied to estimate the magnitude of casual errors, while systematic errors were analyzed by applying the paired *t* test, according to Houston.[19]

Statistical treatment

Descriptive statistics were performed for the variables at the initial (T_1), final (T_2) and post-retention (T_3) phases, and for the differences between initial and final, (characterizing treatment correction), and

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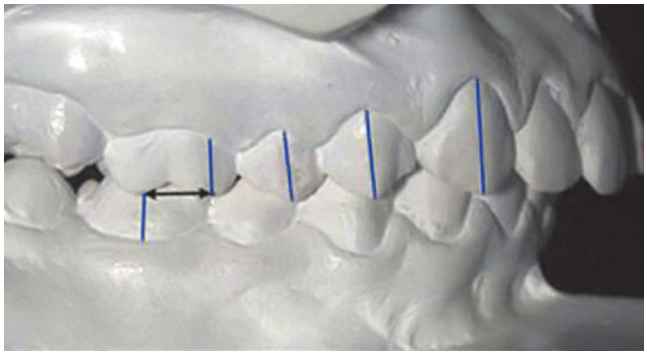


Figure 1 - Molar relationship measurement.

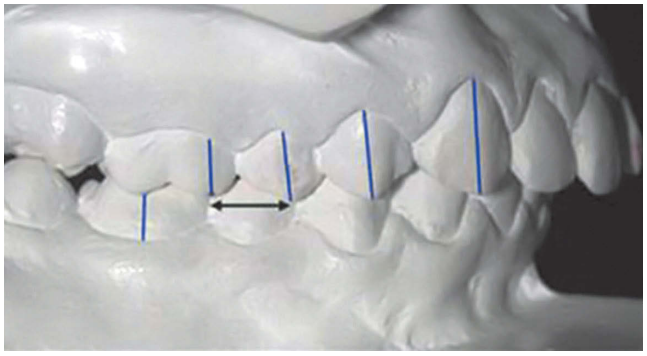


Figure 2 - Second pre-molars relationship measurement.

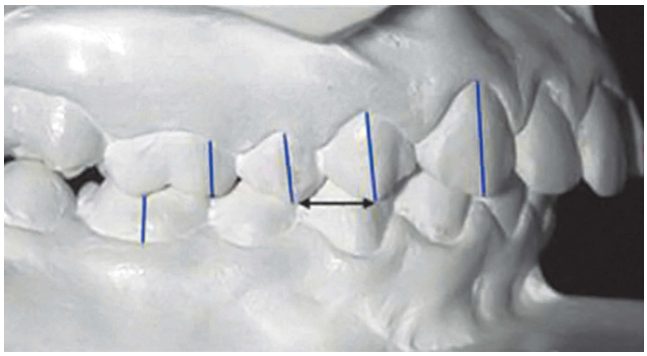


Figure 3 - First pre-molars relationship measurement.

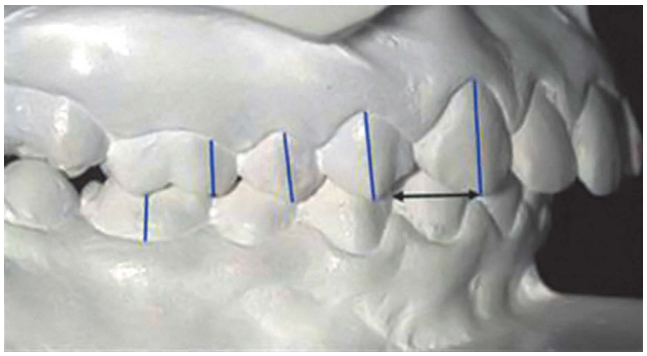


Figure 4 - Canines relationship measurement.

between the final and post-retention stages, (characterizing the change during post-retention). There was also descriptive statistics of the ages at initial, final and post-retention stages and the duration of treatment, retention and post-retention evaluation.

To evaluate variable changes between phases, the dependent ANOVA for repeated measures (repeated measures ANOVA) was used and in the presence of a significant result, Tukey's test was applied subsequently.

The Pearson correlation coefficient was calculated to verify the presence of correlation between molar relationship relapse with: severity of initial Class II relationship, treatment time, retention time and time of post-retention evaluation.

To better evaluate the influence of the initial Class II molar relationship severity on the stability of molar relationship, the sample was divided into two groups: Group 1 with ½-cusp or ¾-cusp initial molar Class II relationship, and Group 2, with initial complete Class II molar relationship. Therefore, the independent *t* test was applied for all variables between these two groups.

All tests were performed with the STATISTICA software (Statistica for Windows, Release 6.0, Copyright StatSoft, Inc. 2001), adopting a significance level of 5%.

RESULTS

Table 1 presents the results of the evaluation of systematic and casual errors, by evaluating the paired *t* test and Dahlberg' formula,[11] applied to all studied variables.

The descriptive statistics results (mean, standard deviation, minimum, maximum and number) of the variables molar relationship (MR), second premolars relationship (2PMR), first premolars relationship (1PMR) and canine relationship (CR) in every evaluated stage (T_1, T_2 and T_3) and periods (T_2-T_1 and T_3-T_2) are shown in Tables 2 to 5.

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Table 6 shows the results of the analysis of variance (ANOVA) and Tukey's test for the variables molar relationship, relationship of first and second premolars and canines, at the initial, final and post-retention stages.

Table 7 presents the results of the Pearson correlation test to evaluate the correlation of the severity of Class II relationship with the post-retention relapse.

Table 8 shows the test results of the Pearson correlation test to determine the correlation of relapse and treatment time, retention time and time of post-retention evaluation.

Table 9 presents the results of the independent t test between groups 1 (½-cusp or ¾-cusp Class II) and 2 (complete Class II).

DISCUSSION

Methods

From the medical records of each patient general data such as date of birth, gender, type of appliance and mechanics used, date of beginning and end of treatment, duration of the use of the retainers, date of post-retention evaluation were collected. With these data, treatment, retention and posttreatment evaluation times, age at the beginning and end of treatment, and at post-retention stage was assessed.

The choice of the methodology to be used should be based on the objective of the study. Since the purpose of this study was to evaluate the stability and relapse of molar relationship in the post-retention stage, the best method for evaluating molar relationship are study models. Although this method does not allow the clinical and radiographic analysis, the study models alone provide information related to diagnosis and orthodontic treatment.[6,15] Furthermore, it has been shown that there is a poor association among the occlusal characteristics and the morphology obtained in the lateral cephalograms and better prediction of orthodontic results can be obtained by occlusal indexes than by cephalometrics.[1] The fact that occlusal characteristics do not always reflect craniofacial morphology was evidenced by Pancherz, Zieber and Hoyer,[35] who observed similar cephalometric characteristics when comparing Class II, division 1 and 2, contradicting the widespread idea that the severe overbite of Class II division 2 malocclusion is related to a more horizontal skeletal pattern of this malocclusion.[21] Although this

Table 1 - Results of t test and Dahlberg formula, applied to the variables molar relationship, second premolar relationship, first premolar relationship and canine relationship, for estimation of systematic and casual errors, respectively (n=45).

Variables	1st. Measurement		2nd. Measurement		Dahlberg	p
	Mean	SD	Mean	SD		
MR	2.03	1.80	2.08	1.88	0.21	0.183
2PMR	3.47	2.05	3.54	2.05	0.26	0.056
1PMR	3.35	2.15	3.40	2.16	0.16	0.099
CR	4.40	2.29	4.43	2.21	0.27	0.530

Table 2 - Results of the descriptive statistical analysis for the variable molar relationship (MR), in all stages and periods evaluated.

Variables	Mean	SD	Minimum	Maximum	n
MR T_1	4.65	1.52	1.85	8.40	39
MR T_2	0.50	0.70	0.00	3.05	39
MR T_3	0.62	0.74	0.00	2.80	39
MR T_2-T_1	-4.14	1.47	-7.15	-0.85	39
MR T_3-T_2	0.12	0.78	-2.10	2.50	39

Table 3 - Results of the descriptive statistical analysis for the variable second premolar relationship (2PMR), in all stages and periods evaluated.

Variables	Mean	SD	Minimum	Maximum	n
2PMR T_1	5.89	1.73	2.50	9.15	39
2PMR T_2	1.39	0.83	0.20	3.55	39
2PMR T_3	1.60	0.94	0.00	4.25	39
2PMR T_2-T_1	-4.50	1.65	-8.20	-0.95	39
2PMR T_3-T_2	0.21	0.90	-1.60	2.85	39

Table 4 - Results of the descriptive statistical analysis for the variable first premolars relationship (1PMR), in all stages and periods evaluated.

Variables	Mean	SD	Minimum	Maximum	n
1PMR T_1	5.88	1.64	2.30	9.75	39
1PMR T_2	1.03	0.78	0.00	2.80	39
1PMR T_3	1.33	0.82	0.00	3.35	39
1PMR T_2-T_1	-4.85	1.71	-9.40	-0.30	39
1PMR T_3-T_2	0.30	0.73	-1.15	2.05	39

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Table 5 - Results of the descriptive statistical analysis for the variable canine relationship (CR), in all stages and periods evaluated.

Variables	Mean	SD	Minimum	Maximum	n
CR T_1	7.22	1.64	2.75	10.45	39
CR T_2	2.32	0.94	0.55	4.70	39
CR T_3	2.28	1.04	0.20	5.55	39
CR T_2-T_1	-4.89	1.65	-8.85	0.60	39
CR T_3-T_2	-0.04	0.89	-1.80	2.50	39

Table 7 - Results of the Pearson's correlation test to verify the correlation of the severity of the Class II relationship with the post-retention relapse.

Correlations	r	p
MR T_1 x MR T_3	0.107	0.515
MR T_1 x MR T_3-T_2	-0.173	0.292
2PMR T_1 x 2PMR T_3	0.143	0.382
2PMR T_1 x 2PMR T_3-T_2	-0.159	0.331
1PMR T_1 x 1PMR T_3	-0.012	0.938
1PMR T_1 x 1PMR T_3-T_2	-0.172	0.293
CR T_1 x CR T_3	-0.049	0.763
CR T_1 x CR T_3-T_2	-0.354	0.026*

* Statistically significant difference for $p < 0.05$.

Table 6 - Results of the analysis of variance (ANOVA) and Tukey tests for the variables molar relationship, first and second premolars relationship and canine relationship (n=39), between the initial, final and post-retention stages (same letters mean no statistically significant difference).

Variables	Initial (T_1)	Final (T_2)	Post-retention (T_3)	p
	Mean ± SD	Mean ± SD	Mean ± SD	
MR	4.65 ± 1.52 [a]	0.50 ± 0.70 [b]	0.62 ± 0.74 [b]	0.000*
2PMR	5.89 ± 1.73 [a]	1.39 ± 0.83 [b]	1.60 ± 0.94 [b]	0.000*
1PMR	5.88 ± 1.64 [a]	1.03 ± 0.78 [b]	1.33 ± 0.82 [b]	0.000*
CR	7.22 ± 1.64 [a]	2.32 ± 0.94 [b]	2.28 ± 1.04 [b]	0.000*

* Statistically significant difference for $p < 0.05$.

Table 8 - Results of the Pearson's correlation test to verify the correlation of the relapse with treatment time, retention time and time of post-retention evaluation.

Correlations	r	p
MR T_3-T_2 x TREATT	-0.205	0.210
MR T_3-T_2 x RETENT	-0.006	0.968
MR T_3-T_2 x POSTR	-0.373	0.019*

* Statistically significant difference for $p < 0.05$.

Table 9 - Results of independent t test, between the groups divided in ½-cusp or ¾-cusp Class II and complete Class II.

Variables	Group 1 – ½-cusp or ¾-cusp Class II (n=16)		Group 2 – Complete Class II (n=23)		p
	Mean	SD	Mean	SD	
ID T_1	13.27	1.11	12.71	1.25	0.164
ID T_2	15.10	1.35	15.17	1.42	0.895
ID T_3	20.18	2.03	21.87	2.84	0.048*
TREATT	1.83	0.49	2.45	0.94	0.021*
RETENT	1.58	0.55	1.65	0.46	0.685
POSTR	5.29	1.57	6.70	2.46	0.051
MR T_1	3.53	1.03	5.43	1.31	0.000*
MR T_2	0.25	0.39	0.67	0.82	0.064
MR T_3	0.48	0.78	0.72	0.71	0.339
MR T_2-T_1	-3.28	1.17	-4.75	1.36	0.001*
MR T_3-T_2	0.23	0.75	0.04	0.81	0.460
2PMR T_1	4.52	0.90	6.84	1.52	0.000*
2PMR T_2	0.91	0.62	1.72	0.81	0.001*
2PMR T_3	1.33	0.95	1.79	0.92	0.141
2PMR T_2-T_1	-3.61	1.17	-5.11	1.67	0.003*
2PMR T_3-T_2	0.42	0.76	0.06	0.98	0.230
1PMR T_1	4.50	1.08	6.85	1.23	0.000*
1PMR T_2	0.64	0.61	1.31	0.77	0.006*
1PMR T_3	1.17	0.79	1.45	0.83	0.303
1PMR T_2-T_1	-3.86	1.40	-5.53	1.59	0.001*
1PMR T_3-T_2	0.53	0.63	0.13	0.75	0.096
CR T_1	6.00	1.73	8.07	0.89	0.000*
CR T_2	1.96	0.83	2.58	0.95	0.043*
CR T_3	2.23	0.84	2.31	1.18	0.804
CR T_2-T_1	-4.04	1.77	-5.49	1.29	0.005*
CR T_3-T_2	0.26	0.88	-0.26	0.85	0.067

* Statistically significant difference for $p < 0.05$.

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study did not use occlusal indexes, molar relationship measurement, a characteristic that can be well observed in study models, was used.[6,9]

Andrews[4] defined the six keys to normal occlusion based exclusively on the information contained in 120 study models, and these six keys are valuable parameters to obtain an ideal static occlusion. Similarly, the occlusal evaluation is an important research tool regarding the results of orthodontic treatments.[2,7,43] Therefore, this study performed the measurement of molar relationship on study models, a method that is simple and objective, and has previously been used in several studies.[10,12,23,39]

All measurements were made from photographs of the study models of the three phases for each patient. The study models were photographed with a D-80 camera, with a 105 mm close-up lens and circular flash (Nikon Corporation, Japan) with 300 dpi. The use of this lens prevents any distortion of the image. From each model, two lateral photographs were obtained, one of the right side and one of the left, with the buccal surfaces of the posterior teeth parallel to each other. The digital images were inserted into a computer and analyzed with Dolphin Imaging software version 10 (Dolphin Imaging and Management Solutions, Chatsworth, CA, USA). This program magnifies each image by means of the size in dpi, to be informed by the examiner. For each variable, two points are marked and the distance between them is thus calculated by the software. The accuracy of measurements was 0.01 mm. For the statistical analysis, the average of the right and left sides of each of the measures was obtained.

The main advantage of this measurement method is that the images, once inserted in the Dolphin software, can be magnified on the computer screen, or even displayed with a multimedia projector, and the points marked with the aid of a mouse connected to the computer. This possibility of image magnification greatly facilitates the visualization of the point to be marked, minimizing the possible methodological errors, as shown in Table 1.

According to Houston,[19] for an accurate analysis, the object of study should be reevaluated a minimum of 25 times. Thus, to evaluate the intra-examiner error, new measurements of the studied variables (molar relationship, relationship of second premolars, relationship of first premolars and canine relationship, Figures 1, 2, 3 and 4, respectively) were performed on study models of 15 patients randomly selected from the total sample, a total of 45 pairs of models, measured one month after the first measurement. The results of the two measurements were then subjected to the formula proposed by Dahlberg,[11] to obtain the casual errors. To obtain the systematic errors, the paired *t* test was applied.

The results demonstrated the absence of systematic errors. Casual errors were minimum and hence acceptable (Table 1). The greatest casual error occurred for the canine relationship (CR), with value of 0.27 mm. The absence of significant systematic errors and the minimum value of the casual errors observed in this study may result from both the standardization and accuracy of the measurements, and also by the simplicity and objectivity of the measurement used, making this method very reliable and reproducible.

Sample

Since the main objective of this study was to evaluate the stability of molar relationship in the long-term, the selection of the sample was performed aiming to eliminate the largest possible number of factors that could influence the results. Therefore, to evaluate the stability of molar relationship, and also the relationships of first and second premolars and canines, it was necessary to standardize the initial characteristics and the several factors related to the orthodontic treatment. Therefore, the initial malocclusion was calibrated, regarding the type and minimum severity, the treatment protocol used, and the type of appliance.

Therefore, the basic criteria for sample selection was initially Angle Class II malocclusion, with molar relationship of at least half-cusp Class II.[42] Cases could not present rotation of the maxillary and mandibular molars in the initial models, which could influence the measurement of the variables. In addition, all patients should have been treated with fixed orthodontic appliances[14,37] in both maxillary and mandibular arches, without extractions.[14,20,37] All patients used headgear in the maxillary arch and Class II elastics during orthodontic treatment.

Cases treated previously with functional, fixed and removable appliances, and with intraoral distalizers

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were excluded, which may influence the interpretation of the results of this study. It is known that the relapse of the skeletal changes of functional orthopedic appliances occurs after removal of the appliances, and this could influence the results.[32,34] In addition, distalizers also perform a quick distalization of the maxillary molars and generally cause a distal tipping of the crown of these teeth, relapse may be increased in these cases, due to these factors.[27,30]

The presence of permanent teeth erupted up to the first molars and the absence of supernumerary teeth and agenesis constituted criteria of sample selection, since the absence of permanent teeth, the presence of supernumerary and some anomalies related to the shape of the teeth can interfere with the normal development of the occlusion, producing malocclusions that require correction with a different orthodontic mechanics, increasing the complexity and difficulty of the orthodontic treatment, and stability.[6,25]

The sample consisted of a total of 41 patients, selected from the records of the Discipline of Orthodontics, treated by Graduate students (from the Department of Pediatric Dentistry, Orthodontics and Public Health, Bauru Dental School). Only those cases that had complete orthodontic records were selected, with all the forms properly completed, presenting the study models from initial, final and at least two years posttreatment stages.

The time of posttreatment evaluation, in the post-retention stage, is reasonable to observe the stability, one of the purposes of this study, because, according to Al Yami, Kuijpers-Jagtman and van't Hof,[3] about half of the total relapse occurs in the first two years after the end of treatment, with good stability for most of the characteristics in the period of more than five years posttreatment.

The sample selection did not involve the factor quality of finishing, which did not serve as a criterion for exclusion or inclusion. However, assessing the Class II cases treated without extractions in FOB-USP, Barros[6] found that even those cases where there is need for greater patient cooperation,[20,41] were finished, in general, in an acceptable manner. Furthermore, it has been previously demonstrated that the quality of finishing is not related to the long-term results of orthodontic treatments, and an excellent finishing does not guarantee stability.[13,29,33]

RESULTS

Molar relationship

The measurement of the initial Class II molar relationship showed a mean value of 4.65 mm, and was reduced to 0.50 mm after treatment. For the post-retention evaluation, in the long-term, 0.62 mm was found (Table 2). This demonstrates a correction with treatment of 4.14 mm and a minimum relapse of only 0.12 mm (Table 2). As shown in Table 6, after performing the ANOVA and Tukey tests, a statistically significant correction with treatment and stability in the post-retention period could be noted, since there was no statistically significant difference in the molar relationship between the final and post-retention stages. In other words, the molar relationship showed to be stable in the post-retention phase.

The results of this study are in agreement with previous findings in the literature.[10,12,23,39]

Canut and Arias,[10] evaluating Class II division 2 cases, found a mean of post-retention relapse of molar relationship of 0.6 mm, and all patients had a good molar occlusion in the post-retention phase. The authors considered the molar relationship stable at the end of the post-retention period.

Kim and Little[23] found even an improvement in molar relationship in the post-retention period evaluating Class II division 2 cases. At the end of treatment, the cases had a mean value of 1.3 mm for the molar relationship and, in post-retention stage, this value reduced to 1.2 mm, suggesting an improvement in the molar relationship of 0.1 mm.

Uhde, Sadowsky and BeGole,[39] evaluating Class I and Class II cases in the post-retention stage, reported that the mean change in molar relationship is always in relation to the Class II, however, these changes are not relevant, (about 0.50 mm). However, besides including Class I and Class II cases, which directly influences the results, the authors also included cases treated with and without extractions.

However, Fidler et al[12] found a significant relapse of molar relationship between the final and post-retention stages. However, although statistically significant, this relapse had low values of 0.34 mm for the molar relationship on the right side and 0.33 mm on the left side. Perhaps this difference with the present study was due to the fact that the authors selected cases with Class II malocclusion treated successfully

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at the end of treatment, and in the present study, the final treatment outcome of the Class II was not considered for the sample selection.

The literature shows stability of the molar relationship, especially in Class II, division 2 cases. Regarding the Class II division 1 malocclusion, this study showed slightly better results than those found in the literature.[12]

Second premolar relationship

The initial measurement of the second premolars relationship presented a mean value of 5.89 mm, being reduced to 1.39 mm after treatment. For the post-retention evaluation, in the long-term, 1.60 mm was found (Table 3). This demonstrates a correction of 4.50 mm, and a relapse of 0.21 mm (Table 3). As shown in Table 6, after performing the ANOVA and Tukey tests, a statistically significant correction with treatment and stability in the post-retention period could be noted, since there was no statistically significant difference of the second premolars relationship between the final and post-retention stages.

The study of Kim and Little[23] showed the same trend, however, in the final stage, the value of the premolars relationship was slightly higher than normal, and this value remained higher in the posttreatment stage. The initial value of the Class II premolars relationship was 4.6 mm, being corrected to 2.2 mm at the end of treatment and relapsed to 2.5 mm in the post-retention stage.

First premolar relationship

The initial measurement of the first premolars relationship presented a mean value of 5.88 mm, being reduced to 1.03 mm after treatment. For the post-retention evaluation, in the long-term, 1.33 mm was found (Table 4). This demonstrates a correction of 4.85 mm, and a relapse of 0.30 mm (Table 4). As shown in Table 6, after performing the ANOVA and Tukey tests, a statistically significant correction with treatment and stability in the post-retention period could be noted, since there was no statistically significant difference in the first premolars relationship between the final and post-retention stages.

Canine relationship

The initial measurement of the canine relationship presented a mean value of 7.22 mm, being reduced to 2.32 mm after treatment. For the post-retention evaluation, in the long-term, 2.28 mm was found (Table 5). This shows a correction of 4.89 mm, and an improvement in the post-retention period of 0.04 mm (Table 5). As shown in Table 6, after performing the ANOVA and Tukey tests, a statistically significant correction with treatment and a complete stability in the post-retention period could be noted, since there was no statistically significant difference of the canine relationship between the final and post-retention stages, and even a small improvement could be seen.

Kim and Little[23] found results similar to the present study. The initial Class II canine relationship had value of 5.3 mm, and at the end it was corrected to 1.6 mm and remained stable, showing the same value of 1.6 mm in the post-retention stage.

Correlations

To verify the correlation between the severity of the Class II relationship with the post-retention relapse, and the relapse of Class II molar relationship with treatment time, retention time and time of post-retention evaluation, the Pearson correlation test was used (Tables 7 and 8).

There was a correlation of the initial canine relationship with relapse (Table 7).

There was correlation of molar relationship relapse with the time of post-retention evaluation (Table 8). However, this correlation was negative, indicating that the longer the time of post-retention evaluation, the lower the relapse of molar relationship. This finding seems unreasonable; however, since patients were mostly young, at the end of orthodontic treatment, they still showed growth in the post-retention stage. As the growth tends to improve the relationship of skeletal bases,[18] it is natural that the if time has passed until the post-retention evaluation, the patient will have more growth, favoring the stability of the correction of the Class II molar relationship.

Intergroups comparison

To check the influence of the severity of the Class II molar relationship in the initial stability of the molar relationship, the sample was divided into two groups: Group 1 with initial half-cusp or ¾-cusp Class II molar relationship, and Group 2, with ini-

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tial complete Class II molar relationship. Therefore the independent *t* test was applied for all variables between these two groups.

There was compatibility between the two groups for the initial and final ages, and only the post-retention age showed a statistically significant difference (Table 9). Subjects in Group 2 (complete Class II) had an older age in the post-retention stage than the subjects in Group 1. However, despite the complete Class II group had presented an older age in the post-retention stage, the time of post-retention evaluation of this group was not statistically significant higher than the group with ½-cusp and ¾-cusp Class II. The retention time was also compatible between the two groups studied (Table 9).

Regarding treatment time, the group with complete Class II showed longer treatment than the ½-cusp and ¾-cusp Class II group, and this difference was statistically significant (Table 9). This was expected since it is known that the severity of malocclusion, especially the severity of the Class II, when treated without extractions, can significantly increase treatment time.[6,20,40]

Regarding the initial molar relationship, as group selection was based on the severity of this relationship, a significant difference between the groups, was expected (Table 9). Obviously, the complete Class II group had a significantly higher value than the group with less severity. The molar relationship at the end of treatment and at the post-retention stage did not differ between the two groups (Table 9). There was also a difference in the amount of correction with treatment, which also was expected, because if the Class II molar relationship was more severe in Group 2, a greater correction of this relationship was really necessary in this group (Table 9). The molar relationship relapse between the two groups did not present a statistically significant difference, however, it was observed that the molar relationship presented a relapse of 0.23 mm in the group with less severity and only 0.04 mm in the group with greater severity. This evidence reinforces the findings of this study that there is no relationship of the initial Class II severity with molar relationship relapse.

The same pattern of results was observed for the first and second premolars and canine relationship. There were statistically significant differences between the two groups for these relationships in the initial (T_1) and final stage (T_2) and the change with treatment (T_2-T_1) (Table 9). For the relationships at the beginning of treatment, as explained above for the molar relationship, this result was expected due to the greater Class II severity in Group 2. Thus, it was also expected that the correction with treatment was greater, as confirmed by the results. However, there was also a significant result for these relationships at the end of treatment. Group 2, with complete Class II, presented a deficient finishing for the premolars and canine relationships.

A very important factor to be considered is the need for patient cooperation. The successful Class II malocclusion treatment without extractions is extremely connected to patient cooperation. It should be noted that a severe initial malocclusion, demands greater need for patient cooperation to achieve a satisfactory final result.[6,42] According to Barros,[6] the treatment of a complete Class II without extraction, in relation to two maxillary premolar extractions, requires approximately twice the degree of patient compliance.

Due to the fact that Group 2 includes only complete Class II malocclusion cases, it could be assumed that the greater severity of molar relationship at the beginning of treatment and hence the greatest amount of correction during treatment would influence the maintenance of long-term results.[28] However, this association was not confirmed by the present study, since both groups had a stability without statistically significant differences for the molar, premolar and canine relationships.

Araki[5] also found no major posttreatment changes in the group where the change of molar relationship was higher during treatment, and speculated that it probably occurred due to the proper retention of the dental relations obtained.

By studying the stability in the long-term post-treatment of Class II malocclusion by means of the Herbst appliance, Hansen, Pancherz and Hägg[16] observed that, when the maxilla and the mandible are well connected in a stable Class I relationship, the strength of the maxillary growth can be transmitted to the mandible and vice versa. For this reason, it is essential to finish treatment with the best possible intercuspation.

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FINAL CONSIDERATIONS

It is considered that the stability of the correction of dental relationships, such as molar and canine relationships, are primary goals of a successful orthodontic treatment.

The stability of dental relationships is the most important aim to be achieved,[36] because relapse was clearly considered, in a clinical assessment of dentists and patients, as the cause of dissatisfaction in relation to orthodontic treatment. The posttreatment changes of the skeletal characteristics have secondary importance, since they are not visible in the clinical evaluation, but should also be aimed, because these changes may reflect changes in tooth position.[5]

The present study demonstrated a relative occlusal stability of the molar, second and first premolars and canine relationships, as the posttreatment changes were minimal. This is a very important data for planning and treating the cases, because, apart from the cephalometric data of the patients, it is known that at least the occlusal relationship, considered as the most important, is almost maintained in the long-term.

It is also important to highlight that there is a wide individual variability of stability and relapse, since it has a multifactorial cause, and there are several factors related to it, such as craniofacial growth, patient compliance with the use of retainers.[26]

CONCLUSIONS

According to the studied sample and to the methodology used, it can be concluded that:

- There was a non significant relapse of molar relationship, on average 0.12 mm. The relapses of premolars and canine relationships were also not significant.
- There was a significant correlation only between molar relationship relapse and time of post-retention evaluation.
- When the sample was divided into two groups, with half-cusp and ¾-cusp Class II and with complete Class II at the beginning of treatment, no difference in the relapses of molar, premolars and canine relationships could be found .
- The Class II molar relationship correction remained stable and the initial severity did not influence molar relationship relapse.

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A comparative clinical study of the failure rate of orthodontic brackets bonded with two adhesive systems: Conventional and Self-Etching Primer (SEP)

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Objective: This study compared the clinical performance of orthodontic brackets bonded with Transbond adhesive paste after two priming systems: a two-stage conventional system (acid etching + Transbond XT adhesive primer) and a single-stage self-etching primer (SEP) (Transbond Plus).

Methods: The sample comprised 480 metal brackets bonded to the teeth of 24 consecutive patients treated for 36 to 48 months. A split-mouth design was used for bonding, and both systems were used in each patient. Bracket failure rates for each system were analyzed; and failure causes as reported by the patients and the quadrant of teeth for which brackets failed were recorded.

Results: The conventional system group had a failure rate of 5.41%, whereas the rate for SEP was 4.58%. In this group, there were 5 failures (38.4%) in the right maxillary quadrant, 2 (15.4%) in the left maxillary quadrant, 4 (30.8%) in the right mandibular quadrant, and 2 (15.4%) in the left mandibular quadrant. In the SEP group, there were 4 (36.4%) failures in the right maxillary quadrant, 1 (9%) in the left maxillary quadrant, 3 (27.3%) in the right mandibular quadrant, and 3 (27.3%) in the left mandibular quadrant. Results of descriptive statistical analysis and odds ratio did not show any significant differences between rates (p = 0.67).

Conclusion: The clinical efficiency of SEP was similar to that of the conventional system.

Keywords: Orthodontic brackets. Bonding. Dental adhesive.

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INTRODUCTION

The sixth generation of adhesive systems, called self-etching primers (SEP), reduced the number of bonding stages because it eliminated the need to apply phosphoric acid and, consequently, reduced clinical time and the risk of contamination. However, Transbond Plus SEP (3M Unitek, Monrovia, CA) has a more conservative pattern and produces a smaller amount of demineralization and less penetration into the enamel surface than phosphoric acid (37%).[1]

Dominguez-Rodriguez et al conducted a series of studies from 2002 to 2004 to evaluate the reliability of this SEP system. In an *in vitro* study to evaluate resistance to traction,[2] brackets were bonded to human premolars extracted for orthodontic reasons. Mean resistance to traction was 6.25 ± 1.61 MPa, practically the same optimal values recommended in the literature[3,4] (6 MPa).Their next *in vitro* study of bonding to extracted human premolars compared SEP resistance to traction with that of a conventional system using Victory (3M Unitek, Monrovia, CA) metal brackets and the adhesive pre-coated (APC) system.[5] Mean values were 8.1 ± 2.7 MPa in the SEP group, and 10.3 ± 3.2 MPa for the conventional system, similar to those found by Grubisa et al[6] in another comparative study: 7.7 ± 4.2 MPa for SEP and 9.8 ± 4.2 MPa for the conventional system.

These findings suggested that the clinical applicability of SEP should be confirmed in clinical trials. A study to measure the frequency of metal bracket failure during orthodontic treatment included 278 teeth of 17 patients.[7] All brackets were bonded using a SEP system. Patients were followed up for 30 months, and results showed a bracket failure rate of 5.8% for all the teeth included in the analysis. Failure causes were associated with excessive application of force and with biting food that should have been excluded from regular diet according to initial instructions, such as candy and lollypops.

Reis et al,[8] who followed up 30 patients for 18 months, found a failure rate of 15.6% for SEP and 17.6% for the conventional system, a difference that was not statistically significant. Pandis et al[9] conducted a study to compare SEP with the Orthosolo and Enlight conventional systems in 62 patients for 12 months and found that the risk of failure in the SEP group was not any greater than in the conventional system group.

Elekdag-Turk et al,[10] in 2008, compared failure rates between SEP and the conventional adhesive systems. They followed up patients for 6 months and reported that there were no significant differences between the adhesive systems under study and that both had a failure rate of 0.6%. In another study, the same authors[11] compared the failure rates of self-ligating brackets bonded with either SEP or a conventional adhesive system. They followed up patients for 12 months and reported that there was a significant difference between the two systems, as the SEP group had a rate of 4.7%, whereas the rate for the conventional system was 1.7%.

Santos et al[12] conducted a study with a 6-month follow-up; they found that failures were associated with the adhesive-enamel interface, and that failure rates for SEP and the conventional system were 10.6% and 7.4%. In the same way, Murfitt et al[13] recorded bracket failure rates for 12 months and found a significantly greater rate for teeth to which brackets had been bonded with SEP (11.2%) rather than the conventional adhesive system (3.9%).

In a recent study, Paschos et al[14] compared different SEP adhesive systems: Transbond Plus (3M Unitek, Germany) and Clearfil Protect Bond (Kuraray Medical, Japan). They included 480 brackets in their study and, after a 12-month follow-up, found a failure rate of 5.4% (26 brackets), which was significantly greater than that found for brackets bonded with Clearfil Protect Bond (4.4%).

This clinical study used the split-mouth bonding design to evaluate bracket failure rates in individuals that underwent full orthodontic treatment for 36 to 48 months using the conventional system with acid etching (37% phosphoric acid) together with the Transbond XT adhesive (3M Unitek, Monrovia, CA) and the Transbond Plus SEP (3M Unitek, Monrovia, CA).

MATERIAL AND METHODS

The sample comprised 480 metal brackets (Victory) bonded to the teeth of 24 consecutive patients that were treated in the MBT Orthodontic Treatment Clinic of São Paulo University. No patient had received previous orthodontic treatment. After diagnosis and treatment plan, patients were treated with extraction of the four first premolars.

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The split-mouth design was used for bracket bonding, and was divided into groups randomly. Patient dentition was divided into four quadrants, and one adhesive system was used in the right maxillary and left mandibular quadrants, and the other, in the left maxillary and right mandibular quadrants. In one group, 240 teeth underwent etching and priming using the two-stage conventional method: Acid etching with 37% phosphoric acid and bonding with Transbond XT adhesive paste. The other 240 teeth were primed using the Transbond Plus SEP (3M Unitek, Monrovia, CA). After that, all brackets were bonded using the Transbond XT resin.

The same bracket bonding protocol was strictly followed for each patient. First, prophylaxis was performed with rubber cup, pumice and water spray using a low-speed handpiece, and then teeth were rinsed with water. The place where to bond the brackets was defined according to the tables of the MBT treatment system and marked with a lead pencil on the buccal surface of the teeth. After that, the field was isolated using cheek retractors, and the actual process of bonding the brackets started.

In the quadrants chosen for the Transbond Plus SEP system, application followed the manufacturer's instructions: 1) contents of the first two reservoirs were squeezed into the third; 2) a micro brush was used to mix and apply the liquid to the enamel surface in circular movements while applying some pressure for three seconds; 3) excessive liquid was removed with a gentle air burst to leave a thinner liquid layer on the enamel. After that, direct bonding was performed. A thin layer of Transbond XT resin was applied to the base of each bracket. After removing excess resin, a halogen light was used for curing for 40 seconds (10 s for each surface).

In the contralateral quadrants chosen for conventional bonding, the field was isolated, teeth underwent acid etching (37% phosphoric acid; Dentsply) for 20 seconds, rinsing for 5 seconds per tooth, and drying for 10 seconds. A thin layer of Transbond XT adhesive primer was then applied to the surface of the tooth using a micro brush. The procedures to dispense resin onto the bracket base and directly bond the brackets were the same as those for bonding in the contralateral quadrant, which used the SEP system.

The leveling phase started on the same day. Patients received routine instructions about appliance cleaning and care, particularly about foods and habits that may damage the appliance.

Bracket failures were controlled and their causes and corresponding tooth were recorded during all treatments, which ranged from 36 to 48 months.

Statistical analysis

Descriptive statistics was used to analyze the number of bracket failures per individual, what bonding system was used in maxilla and mandible, failure causes and their percentages, and mean time between bonding and failure in months. The values obtained for bracket failure were compared (odds ratio – 0.839; p = 0.676).

RESULTS

The results are presented in Table 1 to 5.

DISCUSSION

Bracket failure rates were compared for the conventional and the SEP bonding systems. Orthodontic treatments with extraction of the maxillary and mandibular first premolars in 24 consecutive patients were evaluated during the different treatment phases: Leveling, alignment, space closure and finishing. Several factors were taken into consideration: Whether the tooth was in the maxilla or mandible; the quadrant (right and left); the type of tooth (incisor, canine, premolar and molar); failure causes; and mean time between bonding and failure.

Efficient bracket bonding and low failure rates are important factors in orthodontic treatments. As a complete orthodontic treatment may last from 24 to 48 months, bonding efficiency of the two systems under study was evaluated during all the treatments, which ranged from 36 to 48 months.

A split-mouth design for bonding was used to compare the two systems in each patient. This randomized method ensures that, of each 10 brackets bonded consecutively, 5 will be bonded using the conventional system in the maxillary right quadrant and 5 will use the SEP in the maxillary left quadrant. The same bonding system is used in contralateral quadrants so that, together with different bonding systems, analyses may include eating habits and individual mastication forces for each patient.[12,13]

Tables 1 and 2 show that the distribution of failure was similar in the maxilla and mandible for both

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Table 1 - Number of failures according to tooth and bonding system in the upper arch.

Tooth	Right quadrant		Left quadrant	
	SEP	Conventional	SEP	Conventional
Incisors	0	2	0	0
Canines	1	0	0	0
Premolars	2	2	0	2
2nd molars	1	1	1	0
Total	4	5	1	2

Table 2 - Number of failures according to tooth and bonding system in the lower arch.

Tooth	Right quadrant		Left quadrant	
	SEP	Conventional	SEP	Conventional
Incisors	0	2	0	0
Canines	1	1	0	1
Premolars	0	1	1	1
2nd molars	2	0	2	0
Total	3	4	3	2

Table 3 - Total number of bracket failures according to bonding system.

Quadrant	SEP	Conventional
Right maxillary	4	5
Left maxillary	1	2
Right mandibular	3	4
Left mandibular	3	2
Total	11	13
% of failures	4.58	5.41

Table 4 - Cause of bracket failure (number and percentage of failures).

Failure cause	SEP	Conventional
Biting candy	3 (27.3%)	4 (30.7%)
Biting olive	1 (9%)	1 (7.7%)
Trauma	2 (18.2%)	0
Diet in general	5 (45.5%)	8 (61.6%)

Table 5 - Mean time between bonding and failure (months).

Teeth	Upper arch				Lower arch			
	Right quadrant		Left quadrant		Right quadrant		Left quadrant	
	SEP	Conventional	SEP	Conventional	SEP	Conventional	SEP	Conventional
Incisors	0	9.5	0	0	0	5	0	0
Canines	1	0	0	0	24	2	0	6
Premolars	1	1	0	2	0	2	36	2
2nd molars	3	1	11	0	1	0	1.5	0

SEP (maxilla = 5; mandible = 6) and conventional (maxilla = 7; mandible = 6) systems. Studies in the literature, as well as this study, found a nonsignificant difference in bracket failure rates between the two arches. There were 12 failures in the maxilla and 12 in the mandible, which confirmed equal rates.

The comparison of right and left quadrants in the maxilla and in the mandible revealed that there were 16 failures in the right quadrant (SEP = 7; conventional = 9) and 8 in the left quadrant (SEP = 4; conventional = 4). One possible explanation for that might be the patients' masticatory habits.[9] *In vivo* studies should take into consideration factors that might be associated with failure rates, such as patient socioeconomic status, malocclusion classification and type of mechanics used during treatment. Moreover, masticatory forces vary according to facial patterns, and diet is associated with cultural factors.[8,11]

The number of times the bracket is handled during bonding should also be evaluated in the analysis of bracket failures. Brackets handled more than three times when a SEP system is used have twice as many chances of failure than those bonded with a conventional bonding system.[13]

Several authors conducted shorter studies to compare SEP and conventional systems, from 6 to 12 or 18 months.[8-14] Our follow-up lasted longer, from 36 to 48 months.

Some authors found that the failure rate for SEP ranged from 0.6%10 to 15.6%[8] and that the SEP performance was equal to or better than that of conventional systems. Of the 240 brackets bonded with each of the two bonding systems, 11 in the SEP group and 13 in the conventional system group failed, which indicates failure rates of 4.58% and 5.41% (Table 3). Odds ratio results showed that there were no signifi-

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cant differences between these values, in agreement with most reports in the literature,[9,10,11,12] but different from studies that found greater failure rates for brackets bonded with SEP than for those bonded with conventional systems.[13,15] The fact that numbers and percentages are very close suggests that both the SEP and the conventional systems are equally efficacious.

Most failures occurred in premolars, at 9 failures, followed by molars, with 7, and the least failures were seen in incisors and canines, at 4 failures each (Tables 1 and 2). These findings are in agreement with studies that reported a three times greater rate for posterior teeth than for anterior teeth.[11,13,16,17] The fact that premolars are the teeth with the highest rate may be explained as a result of several factors: Lower risk of contamination by humidity in the anterior region during bonding; occlusal forces that exceed the limits of adhesive resistance of the brackets; greater amount of prismless enamel, which may affect the quality of micromechanical bonding and result in poor adhesion; and the difficulty to isolate the posterior region.[7]

Mean time between bonding and bracket failure (Table 5) showed great variation and ranged from 1 to 36 months. Despite that, most failures occurred in the first 6 months of treatment, and only four means indicated longer times. Two of these four cases were assigned to the sum of one failure in the beginning of the treatment and one at the end of it. The other two high means represented failures at the end of the treatment. The fact that most failures occurred in the first 6 months may be assigned to one of three causes. First, any problem during bonding becomes evident in the beginning of the treatment. Second, the initial period of the treatment is a time for adaptation of the patient to the diet. Finally, there may be excessive occlusal forces during the initial stage of treatment.[8,11] Some authors have reported a failure rate of up to 82% during this time.[10]

Other studies confirmed the efficacy of SEP systems during the first 6 months of treatment when compared with conventional systems.[8] After a longer treatment time, the difference between failure rates for the two bonding systems may become imperceptible. This is explained by the hydrophilic component of the monomer, which leads to increased water absorption and may weaken the adhesive-bracket interface along time. This was confirmed in our study, because mean time between bonding and bracket failure was greater when the SEP system was used (Table 5).

Regardless of time, failures were assigned to either patient diet in general, because patients did not follow initial diet recommendations, or to trauma (Table 4).

CONCLUSIONS

The efficacy of the SEP bonding system was similar to that of the conventional system, and its use in orthodontics seems to be reliable.

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Effect of dental bleaching after bracket bonding and debonding using three different adhesive systems

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Objective: To evaluate the influence of bonding and debonding of orthodontic brackets on dental in-home bleaching, taking into account three different adhesive systems.

Methods: Forty-four bovine incisors were divided into four groups according to the primer system used for orthodontic bracket bonding. Following the debonding of orthodontic brackets, the teeth were stored in staining solution for 96 hours. Then, teeth were whitened using 10% carbamide peroxide for two weeks at a 6-hour-a-day regime. Standardized digital photographs were taken at the following intervals: T_0 (initial); T_1 (after debonding); T_2 (after pigmentation); T_3, T_4 and T_5 representing 1, 7, and 14 days of bleaching. Repeatability and stability tests were carried out to check the method accuracy. Images were analyzed using Adobe Photoshop 7.0 software considering ($L^\star a^\star b^\star$) color coordinate values and a modified color difference total ($\Delta E'$).

Results: The results of this study (ANOVA and Tukey; $p < 0.01$) demonstrated that after 7 days of bleaching, experimental groups showed significantly less teeth whitening compared to the control group. However, there were no significant color differences between the groups after 14 days, according to values of lightness ($L^\star$).

Conclusions: Regardless of the adhesive primer system applied, bonding and debonding of orthodontic brackets alters the outcome of tooth whitening in the first 7 days of bleaching, however it have no influence on the whitening of the dental structure after 14 days of in-home dental bleaching with 10% carbamide peroxide.

Keywords: Dental bleaching. Orthodontic brackets. Photography. Primer.

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INTRODUCTION

Patients frequently seek cosmetic solutions after orthodontic treatments including changes in tooth color, notably when stains are observed on tooth surface after the removal of orthodontic brackets. Usually, such stains result from pigments in the materials applied in the tooth/bracket interface, since orthodontic devices prevent good hygiene and favor the deposit of chromogenic agents in the interfaces between tooth enamel and orthodontic device which may lead to color alteration on the dental surface.[1]

However, after debonding of orthodontic brackets, residual adhesive (resin tags) remain on teeth, for the bonding process takes place as a result of the micromechanical retention, due to the presence of resin components that infiltrate about 11.8 µm to 18.9 µm into the dental structure, sometimes reaching up to 100 µm into the tooth.[2,3]

Once resin tags have infiltrated the enamel – and some may remain intact even if the enamel's surface layer is removed,[4] they could obstruct the movement of whitening agents within this substrate hence influencing the result of dental bleaching.[5] In addition, since composites are not whitened, as teeth are,[6] their presence could lead to chromatic alterations and prevent the acquisition of a homogenous color on dental surface in the end of the bleaching process.

In face of the scarce literature on dental bleaching after debonding of orthodontic brackets, as well as on the influence of resin tags on dental surface final color, it is necessary to assess occasional differences on the color of teeth whitened after bonding and debonding of orthodontic brackets taking into consideration the different adhesive primer systems.

The first research hypothesis is that the adhesive resin system that remains on tooth enamel after debonding of orthodontic brackets interferes with the achievement of a homogenous surface color. The second research hypothesis is that different adhesive primer systems interfere differently with the outcome of dental bleaching.

MATERIAL AND METHODS

Forty-four incisors previously kept in a 0.1% timol solution were assessed colorimetrically and fifteen were used for the method repeatability test and color stability test. The teeth had their roots cut off with a double-face diamond disc (# 7020, KG Sorensen, Barueri, SP, Brazil) under refrigeration and in low rotation. Dental pulps were removed and crowns were brushed using Robinson brushes and pumice-based toothpaste and water in low rotation. The central region — the most flat surface — on the buccal side of each tooth was outlined and dental crowns were included in transparent self-cured acrylic resin blocks (JET, Artigos Odontológicos Clássico Ltda, São Paulo, SP, Brazil). The specimens were randomly divided into five groups, as shown in Table 1.

The bracket placed on the flattened surface was that of a maxillary lateral incisor ref. 1030209 (Morelli, São Paulo, SP, Brazil), manipulated with the aid of bracket bonding tool (Morelli). The specimens of all groups were placed in the positioning device, their exposed enamels etched with 37% phosphoric acid for 1 minute and underwent bracket-bonding procedures according the instructions provided by the manufacturers of the different adhesive primer systems applied. Before debracketing, the specimens were stored in distilled water for 24 hours at 37 °C.[7,8]

Debonding was carried out mechanically with a straight plier How (Unitek), following the technique proposed by Zachrisson.[9] The remaining composite

Table 1 - Description of experimental groups according to surface treatment, composite resin, whitening procedure and sample size.

GROUPS	SURFACE TREATMENT	COMPOSITE RESIN	BLEACHING AGENT	TOTAL TEETH (n)
Color stability and Repeatability (R)	_____	_____	_____	15
Control (C)	_____	_____	10% carbamide peroxide	11
Self-Etching Primer (SEP)	Transbond plus self-etching primer	Transbond XT	10% carbamide peroxide	11
Transbond Primer (TP)	Phosph. ac. 37% + Transbond Primer	Transbond XT	10% carbamide peroxide	11
Concise Resin (CR)	Phosph. ac. 37% + Concise resin	Concise	10% carbamide peroxide	11

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was removed with a multilaminated bur (K282K – Komet-Brasseler, Lemgo, Germany) in low rotation. The total removal of composite from enamel was verified in a stereoscope microscope (25x).

After bracket debonding, the specimens of groups C, SEP, TP and CR were submerged in a container with aqueous solution containing 250 ml of black tea, 250 ml of coffee, 250 ml of red wine, 250 ml of tobacco solution, 250 ml of coca-cola and 250 ml of artificial saliva, at 37 °C for 96 hours.

After pigmentation, specimens were subjected to the at-home whitening technique, using 10% carbamide peroxide (7.82 pH) (Whiteness Perfect 10% – FGM, Joinville, SC, Brazil).

During bleaching, a standardized 0.2 ml whitening substance was applied over the exposed tooth surface, which was kept there for 6 hours a day, during 2 consecutive weeks. The specimens remained under 100% relative humidity at 37 °C throughout the experiment.[10]

Specimens were photographed using positioning devices, developed with the goal of assessing the enamel color always at the same spot at the different assessment intervals, at the following time points: T_0 = initial, before bracket bonding; T_1 = after debonding and surface polishing; T_2 = after pigmentation; T_3 = after the first day of bleaching; T_4 = after the first week of bleaching; T_5 = after two weeks of bleaching. Specimens in the control group were polished and photographed again at T_1 in compliance with the method applied for experimental groups.

Determining method reliability: Repeatability test

Before starting the experiment, a repeatability test of the photograph shooting and the resulting color measurements was performed on fifteen specimens to ensure the reliability of the method applied. The repeatability test consisted of an assessment of tooth color variation across three photography sessions.

Color stability test on teeth stored in distilled water

This test consisted in the observation of possible color alterations on teeth stored in distilled water at 37° C across the experimental period. Fifteen specimens had their photographic images assessed at T_0 (initial) and T_5 (final) intervals. This so-called group R did not undergo any kind of treatment on their exposed enamel surfaces.

Color measurement of sample

Measurements of L★, a★, b★ color dimensions were carried out at the aforementioned time periods (T_0 to T_5) on all experimental specimens by using the histogram function of the Adobe Photoshop 7.0 software.

The study adopted the CIELAB color system in which colors are defined according to three dimensions: L★ (lightness), a★ and b★ (redness/greenness and yellowness/blueness).[11] The numeric values of L★, a★, b★ obtained from colorimeters and spectrophotometers vary from 0 to 160. In this study, L★, a★, b★ dimensions vary from 0 to 255 because the color assessment relied upon the computer-based readings of digital photographs that are obtained in the RGB color space, with 256 different hues. Therefore, we needed to adjust the numeric value, which suggests clinical significance (DE) (Table 2). So we agreed to name the color difference calculated in this study DE', to prevent wrong comparisons based on DE calculated from L★a★b★ color parameters obtained with colorimeters.

Data assessment

The values of L★ a★ b★resulting from the colorimetric assessment of photographs were statistically evaluated by the MINITAB package.

The ANOVA test (analysis of variance) was performed for repeated data, to check for the statistically significant differences at the intervals and among all groups in the study. Once a positive result was observed for ANOVA, we applied the Tukey parametric statistics to determine the minimum significant differences among groups at each interval and among different intervals within each group, at the 1% significance level.

Table 2 - ΔE CIELAB color variation (0 – 160 scale) and ΔE' RGB color variation (0 – 255 scale).

CIE color space: L (0 to 100); a (-80 to +80); b (-80 to +80)
$\Delta E = [(100)^2 + (160)^2 + (160)^2]^{½}$
$\Delta E = 247.39$
RGB color space: L (0 to 255); a (0 to 255); b (0 to 255)
$\Delta E' = [(256)^2 + (256)^2 + (256)^2]^{½}$
$\Delta E' = 443.40$

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RESULTS

Color stability and repeatability test

The degree of repeatability of the sample was found to be highly reliable, as confirmed by the Analysis of Variance (ANOVA), since no significant difference ($p > 0.01$) was observed among the values of L★ ($F = 0.58$/ $p = 0.57$), a★ ($F = 0.71$/ $p = 0.8$) and b★ ($F = 0.3$/ $p = 0.74$) for each specimen at the three intervals.

With regards to the color stability test on specimens kept in distilled water, the difference in the values of L★, a★, b★ at time points T_0 and T_5 did not result in statistically significant differences throughout the sample storage period (Table 3).

Colorimetric assessment results

Value of L*

The measurement of luminosity values L★, at time points T_0 to T_5, for Control (C), Transbond Primer (TP), Self-Etching Primer (SEP) and Concise Resin (CR) groups are displayed on Table 4 and Figure 1.

Considering differences in lightness among specimens across intervals, it was noted that after bonding and debonding of orthodontic brackets (T_1) teeth in groups SEP and CR displayed statistically significant differences ($p < 0.01$) when compared to teeth in group C (Table 4 and Fig 1). The value of L★ decreased in all groups (C, TP, SEP and CR) between T_1 and T_2, thus demonstrating the darkening of the sample after the pigmentation of the specimens (Table 4 and Fig 1).

A significant increase of L★ between intervals T_0-T_5 and intervals T_2-T_5 (ΔL') was observed (Table 4). Between T_2-T_3 the difference in L★ was not significant for the CR group, indicating a delay in the whitening effect over this group compared to the others. From T_3 to T_4 the variation in L★ values was statistically significant for the Control group only. The difference in the measurement of L★ between T_4 and T_5 was significant ($p < 0.01$) for all groups. At T_4 and T_5 the differences among the four groups were not statistically significant, hence demonstrating the groups' homogenous behavior after two weeks of whitening (Fig 1).

Value of ΔE'

The value of DE', which expresses the total color difference, was determined from the measurement of L★, a★ and b★. There was an increase in the value

Table 3 - Descriptive values of L*a*b* color dimensions related to Group R.

Time points		L*	a*	b*
T_0	$\bar{X}$	159.31	128.22	139.11
	S.D.	3.27	0.427	0.480
T_5	$\bar{X}$	160.17	128.41	139.91
	S.D.	3.20	0.433	0.583

$\bar{X}$ = mean, S.D. = standard deviation $p < 0.01$.

Table 4 - Mean, standard deviation and the value of L* comparing control and experimental groups at time points T_0, T_1, T_2, T_3, T_4 and T_5.

Time points		C group	SEP group	TP group	CR group
T_0	$\bar{X}$	169.11 ^{ABa}	170.15 ^{Aa}	168.97 ^{Aba}	169.12 ^{Aa}
	S.D.	2.75	3.04	3.01	4.07
T_1	$\bar{X}$	170.71 ^{Aa}	175.72 ^{Bb}	173.95 ^{Cab}	176.18 ^{BDb}
	S.D.	3.25	3.00	3.39	3.70
T_2	$\bar{X}$	159.80 ^{Ca}	165.61 ^{Cb}	165.09 ^{Ab}	163.02 ^{Cab}
	S.D.	3.72	2.31	3.23	4.07
T_3	$\bar{X}$	165.01 ^{Ba}	170.51 ^{Ab}	169.81 ^{Bb}	167.62 ^{ACab}
	S.D.	3.61	2.19	2.92	4.26
T_4	$\bar{X}$	171.07 ^{Aa}	171.38 ^{Aa}	171.86 ^{BCa}	171.67 ^{ABa}
	S.D.	2.34	2.55	3.01	3.80
T_5	$\bar{X}$	180.12 ^{Ea}	181.67 ^{Da}	180.89 ^{Da}	181.16 ^{Da}
	S.D.	2.95	3.20	3.44	4.06

$\bar{X}$ = mean, S.D. = standard deviation $p < 0.01$.

$^{A, B, C, D, E}$ show differences within the same groups at the different intervals (columns)

$^{a, b}$ show differences among different groups at the same intervals (rows).

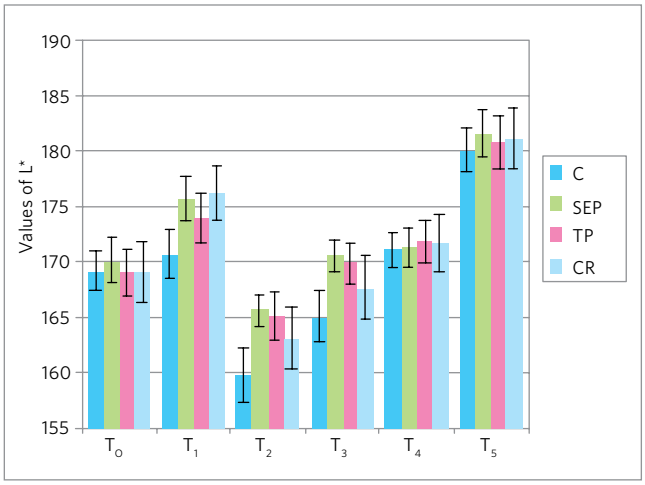


Figure 1 - Graphic representation of the mean values of L* and their respective confidence intervals, considering Control and Experimental groups at the different time intervals ($p < 0.01$).

of DE' from T_0 to T_1 between group C and experimental groups SEP, TP and CR indicating that the processes of bonding and debonding of orthodontic brackets altered the total color of teeth. Such alteration was greater in group CR, which demonstrated a higher value of DE' at T_1 (Table 5) when compared against group C.

From T_0 to T_1 groups SEP and CR displayed significant color difference after the debonding of orthodontic brackets (Table 5). From T_1 to T_2 all groups showed significant color alterations. Groups CR and C displayed the highest values of DE' from T_1 to T_2 (Table 5).

After one day of whitening no significant color difference was detected in any group from T_2 to T_3. However, after one week of whitening (T_2-T_4) significant color difference was displayed in all groups; control group displayed the greatest difference (Table 5).

Upon assessing the difference among groups at a fixed interval, no significant difference was observed among the groups at T_0. Noticeable color difference between C and SEP, and between C and CR was observed after the debonding of brackets (T_1). After one and two weeks of whitening there was no significant color difference among the groups (Table 6).

DISCUSSION

The use of specific colorimetric devices allows a faster and more consistent color assessment than visual assessments alone.[12] The color assessment method applied in this study was the computer-based evaluation of photographic images, supported by Gerlach, Barker, Sagel;[13] Gerlach, Gibb, Sagel;[14] Bentley et al.[11] These authors state that an ideal color assessment method must be reliable, user-friendly and capable of allowing for a retrospective evaluation of results. In addition, using relatively low-cost and widely available equipment like a digital camera is extremely interesting.

The CIELAB color variation system is widely used in dentistry to measure the pigmentation of composites,[15,16] assess the color of dental ceramics[12] and teeth,[17] the chromatic alteration after dental bleaching[5,11,13,14] and after debonding of orthodontic accessories.[18] The advantage of the CIELAB color system is that color differences can be expressed in units (DE), which can be related to the visual perception and the clinical significance.[19] In the literature, the color value difference (DE) which can be clinically noticeable, i.e., which suggests clinical significance, is controversial and shows variations from 2.2 to 4.4.[17] However, Dozic et al[20] found noticeable color differences under clinical conditions only when DE was greater than 3.0 units. As a result, the calculation of DE' will be based on a 3.0-unit DE. Therefore, we applied a common rule-of-three equation to calculate the color value difference (DE') which determines the clinical significance in this study. Because the variation of the mean value of DE is 0 to 247.39 and DE' is 0 to 443.40, when DE equals 3.0 units,[20] DE' will be 5.37 units. Thus, the clinical significance in this study was established for values of DE' > 5.37 units.

Bonding and debonding of orthodontic brackets cause the color on dental surface to change as verified by the increase in the value of L*, statistically significant between T_0 and T_1 for groups SEP, TP and CR, and also clinically significant ($p < 0.01$) for SEP and CR (DE' = 5.63 and 7.12 respectively) (Tables 4 and 5).

Table 5 - Descriptive values of ΔE' at the different evaluated time points.

Intervals	C group	SEP group	TP group	CR group
T_0 - T_1	1.69	5.63	5.03	7.12
T_0 - T_2	9.47	4.63	4.12	6.32
T_1 - T_2	11.07	10.20	9.03	13.33
T_2 - T_3	5.35	5.03	4.96	4.78
T_2 - T_4	12.12	6.90	8.19	9.60
T_2 - T_5	21.40	17.18	17.20	19.21
T_3 - T_4	6.90	2.90	3.79	4.99
T_3 - T_5	16.08	12.24	12.29	14.45
T_4 - T_5	9.34	10.56	9.30	9.74
T_0 - T_5	12.12	12.65	13.09	12.92

$p < 0.01$.

Table 6 - Descriptive values of ΔE' according to the experimental and control groups.

Groups	T_0	T_1	T_2	T_3	T_4	T_5
C - SEP	1.22	5.67	5.86	5.54	0.71	1.62
C - TP	0.60	3.88	5.32	4.83	0.84	0.81
C - CR	0.17	6.10	3.25	2.64	0.74	1.08
SEP - TP	1.20	1.79	0.78	0.73	0.61	0.81
SEP - CR	1.21	0.86	2.61	2.91	0.37	0.56
TP - CR	0.65	2.35	2.10	2.20	0.25	0.29

$p < 0.01$.

The presence of resin tags in the enamel, filling the "pores" created by the acidic condition of the enamel, indicates that it is the driver of those changes.[23] The difference among the experimental groups is probably due to the different adhesive systems that were utilized.[23] The increase in the value of L* in the Concise Resin group was also found in the Osório[23] experiment. The presence of resins within the enamel porosity may have modified a luminous reflection from the dental surface.

Hintz, Bradley and Eliades[5] state that there are three possible variations in bracket debonding procedures that can be responsible for the differences observed among the experimental surfaces: Quantity, quality and depth of resin tags, meaning the change in the morphology of the enamel as a result of the bonding and debonding procedures, and the amount of enamel lost during debonding. Considering these three possibilities, changes observed in the specimens of this study are probably due to the different resin tags left inside the dental substrate because the differences are observed among the experimental groups and between those and the control group. The other aforementioned variables act individually on the specimens, regardless of the group, possibly causing high intragroup variance, which was not observed in this study (Tables 4 and 5).

The decrease in the value of L* from T_1 to T_2 did not occur homogeneously in all groups (C, TP, SEP and CR) (Table 4 and Fig 1). Pigment absorption was greater in groups C and CR. In case of the control group it was due to lack of tags on the dental surface, which favors the diffusion of bleaching agent's molecules [5]. In case of group CR it was due to the improved color stability of light-cured composites as compared to chemically cured composites (Fig 1). The presence of amines and benzoyl peroxide in chemically cured composite products contributes to a greater pigmentation when compared to light-cured ones.[24,25]

After one day of whitening we detected a statistically significant increased value of L* for groups C, SEP and TP. This whitening observed in some groups after six hours of exposure to carbamide peroxide was possibly the result of the pigment deposited on the surface of the specimens. Authors report color alteration on dental surface related to the use of 10% carbamide peroxide, observed clinically after one week of application.[26,27] Therefore, the whitening observed at this interval (T_3) was more related to the superficial removal of the just-deposited than to the bleaching effect itself.

After one week of whitening only the Control group displayed a significant increase in the value of L*, indicating a delayed whitening in the experimental groups as compared to Control at T_3 and T_4. These results are according to those of Hintz, Bradley and Eliades[5] demonstrating the absence of initial response to whitening in the experimental group. These authors report that the experimental group did not respond to whitening for the first two weeks. After two weeks, however, the whitening in the experimental group was faster than that in the control group.

At T_5, after 14 days of whitening, all groups (C, SEP, TP and CR) displayed a significant increase ($p < 0.01$) in the value of L*, which confirms the specimens lighter appearance. It is notable that the teeth became lighter than their initial color (DE' from T_0 to T_5) (Table 5) before pigmentation, confirming the effectiveness of the bleaching agent.

In the end of the whitening process, at T_5, the values of DE' among the groups do not demonstrate any clinically significant color difference (Table 6), hence showing that the bonding and debonding of orthodontic brackets did not interfere on the whitening of the specimens. Hintz, Bradley and Eliades[5] found similar data by the end of the whitening process, according to which either control or experimental groups displayed significant color alterations. Therefore, the first research hypothesis was rejected since the presence of resin tags did not altered the final result of the at-home whitening process carried out for 14 days, thus demonstrating that the quantity of resin remaining within the dental enamel was not enough to prevent the diffusion of the whitening agent inside the dental structure.

Nevertheless, more time in the application of the whitening agent is required to grant the same degree of color modification between the control group and the experimental groups as indicated by existing differences in the value of L* between T_3 and T_4, in control and experimental groups (Table 4). In the current study, due to the bonding and debonding of orthodontic accessories as well as the pigmentation procedures, control and experimental groups began whitening with

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different values of L*. The control groups displayed a darker color than the experimental groups, with differences reaching up to 6 units of L* between C and SE at T_2 (Table 4). Therefore, although the color differences among groups C, SEP, TP and CR at T_4 (after 7 days of whitening) are not significant ($p > 0.01$) (Fig 1), only the control group displayed a statistically significant color change (T_3 and T_4). This finding indicates that the control group changed color more rapidly than the experimental groups, when exposed to bleaching procedures (Table 4 and Fig 1). These findings match those of Hintz, Bradley and Eliades,[5] which state that, initially, tags do make it more difficult for the whitening agent to penetrate the tooth but with a longer exposure to the whitening substance the final result of the whitening process is not compromised.

In the end, the lack of difference among the experimental groups will lead to the rejection of the second research hypothesis, which suggested different group behaviors due to the role played by their specific resin remaining. However, during the experiment, significant color differences were verified for the different adhesive primer systems applied, especially after the debonding of orthodontic brackets and before dental whitening (T_2 and T_3).

Although CIELAB coordinates values are important for an objective color assessment, clinical significance (DE) plays a fundamental role in the determination of what is actually perceived under the social and clinical stand points. Consequently, taking this clinical significance into consideration, the results of this study demonstrate that the bonding and debonding of orthodontic brackets will not prevent the achievement of homogenous dental whitening. Nevertheless, a differentiated clinical protocol should be observed to allow an increased treatment time for the whitening of teeth that have endured bonding and debonding of orthodontic brackets. Despite the similar behavior of human and bovine teeth during staining and bleaching[28] procedures, further studies using human dental substrates and assessing different intervals are required.

CONCLUSION

In light of the findings in this study, it could be concluded that:

1. After 14 days of at-home dental whitening there was no statistically significant color difference among the groups that were subjected to bonding and debonding of orthodontic brackets and the control group.
2. Regardless of the adhesive primer system applied, dental whitening was uniformly achieved in the three experimental groups, without any statistically significant color differences among the groups in the end of dental whitening process.

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Assessment of the dimensions and surface characteristics of orthodontic wires and bracket slots

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Objective: The purpose of this study was to evaluate the dimensions and surface characteristics of orthodontic wires and bracket slots of different commercial brands.

Methods: Thirty metallic brackets (0.022 x 0.028-in and 0.022 x 0.030-in) were divided in three groups: DYN/3M group = Dyna-Lock, 3M/Unitek (stainless steel, or SS); STD/MO group = Slim Morelli (SS); and Ni-Free/MO group = Slim Morelli (Ni-Free). The stainless steel wires (0.019 x 0.025-in) were divided into two groups: MO group = Morelli; and 3M group = 3M/Unitek. The bracket and wire measurements were done by two methods: (a) Surface Electron Microscopy (SEM), and (b) Profile projection. The surface analysis was done qualitatively, based on SEM images and/or by a rugosimeter. The quantitative results were analyzed by ANOVA with Tukey's test ($p < 0.05$) and Student's *t* test.

Results: A significant difference in the dimensions of slots was observed, and the NiFree/MO group showed the greatest changes when compared to the other groups. The analysis of surface topography of the brackets indicated greater homogeneity of the metallic matrix for DYN/3M and STD/MO groups. As for the dimensions of the wires, groups showed statistically different mean heights.

Conclusions: It was concluded that wires and brackets slots can present altered dimensions, which might directly and unintentionally affect the planned tooth movement.

Keywords: Orthodontic brackets. Orthodontic wires. Friction.

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INTRODUCTION

Among the adverse effects of brackets and wires with altered size and geometry, the reduction of dental movements control and increasing friction in the bracket/wire interface stands out.[1,2,26] Undesirable effects such as torque loss of upper and lower incisors (5 – 10°) during space closure mechanics can be attributed to changes in the bracket slot size.[1] The lack of standardization in the wire and bracket slots dimensions will also directly influence on the frictional resistance, hindering the sliding mechanics.[2] It must be observed that with the best combination between bracket and wires, at least 40 g of friction should be included in the force applied to the tooth to start its movement.[3]

Other factors have been linked to the force of friction between brackets and wires during tooth movement; among them, the surface texture of bracket slots and orthodontic wires.[5] Preliminary studies indicate that less homogenous surface characteristics of orthodontic wires are those that have greater surface roughness, which generates more friction in the bracket/wire interface.[5] In addition, orthodontic accessories with less homogenous surfaces tend to be more susceptible to corrosion,[6] which increases the risk of tissue damage, esthetic changes (staining of the tooth by corrosive products) and loss of metal properties.

Companies responsible for the manufacture of orthodontic accessories do not usually indicate their possible size variations; however these variations exist and they are associated to the bracket/wire manufacturing process. Studies point to the need for the introduction of regulatory standards of orthodontic products[24] and therefore technical standards of orthodontic wires and brackets manufacturing were described.[25] Since most orthodontic devices are directly associated with the relationship between size and prescription of brackets and with the section and size of wires, it is important that professionals know more about the materials used in their daily clinical practice. This study aimed to measure the size of rectangular wires and metal bracket slots of different trademarks, *in vitro*. The null hypothesis is the similarity between measures specified by the manufacturers and the actual size of orthodontic brackets and wires. In addition, roughness and surface characteristics of these orthodontic wires and brackets were analyzed.

MATERIAL AND METHODS

a) Analysis of brackets size

Thirty metal edgewise upper right premolar brackets of two different trademarks (3M/Unitek, Monrovia, CA, USA and Dental Morelli, Sorocaba, SP, Brazil) were used. The accessories were divided into three groups of 10 brackets each, as described in Table 1. Two different methods were used to evaluate the slot sizes (height and depth) by one trained operator:

a1) Scanning Electron Microscopy (SEM, Philips XL2000, Holland) – The preparation of brackets consisted of cleaning with acetone by ultrasound (Equipal USC700) for six minutes. After cleaning, the brackets were dried with a nitrogen jet and mounted on metal supports properly identified for SEM observation. After bracket placement, they were pressed against the supports with the aid of a dental probe number 5, so that the bracket bases were parallel to the horizontal plane.

Three frontal images of the brackets were taken: The first was enlarged by 50x, for a general view of the slot conformation (Fig 1); the two others, enlarged by 230x, were taken for a detailed view of each half of the brackets. Thus, for each image at 230x magnification, three measures of the vertical dimension (height) of the slot were analyzed, totaling six measures for each bracket (Fig 1). The average of these values was estimated for each accessory and, finally, for each group.

a2) Profile Projection (PP) – After cleaning the accessories, a profile projector (Nikkon V16, Japan) was used for measuring the vertical and horizontal dimensions of the bracket slots (height and depth). The accessories were fixed to a glass plate using dental wax, so that the slots remained perpendicular to the horizontal plane. The set brackets/glass plate was taken to a projector table, obtaining the shadow projection of the slots. Then, the height and depth of the bracket slot sizes were measured (Fig 2).

Table 1 - Description of studied brackets.

Manufacturer	Bracket	Dimension	Alloy
3M/Unitek	Dyna-Lock; Edgewise Standard (DYN/3M)	0.022 x 0.028-in	Stainless steel (Fe, Ni, Cr)*
Dental Morelli	Slim; Edgewise Standard (STD/MO)	0.022 x 0.030-in	Stainless steel (Fe, Ni, Cr)*
	Slim; Edgewise Standard (Ni-Free/MO)	0.022 x 0.030-in	Stainless steel (nickel free) (chromium, manganese, molybdenum and nitrogen)

* Composition of Stainless Steel Source: Anusavice[7] (1996).

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b) Analysis of the wire dimensions

Four rectangular wire segments (0.019 x 0.025-in) of two different commercial brands (3M/Unitek, Monrovia, CA, USA and Dental Morelli, Sorocaba, SP, BR) were used. Each segment was sectioned into six pieces of approximately 1.97 inches each. The samples were divided into two groups according to the wire trademark (Table 2).

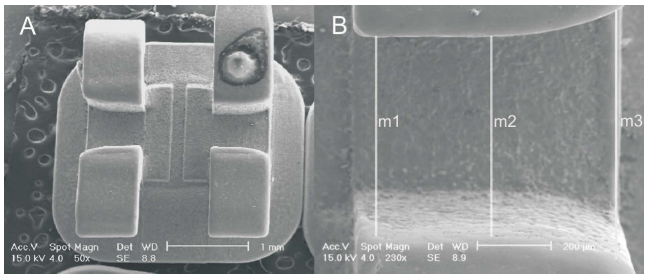


Figure 1 - Scanning Electron Microscopy image of a bracket pertaining to Group III – (**A**) magnification at 50x and (**B**) 230x. The lines m1, m2 and m3 are the regions were the measurements were done to calculate slot height. The large variation of bracket dimensions can be observed, especially on mesial and distal ends.

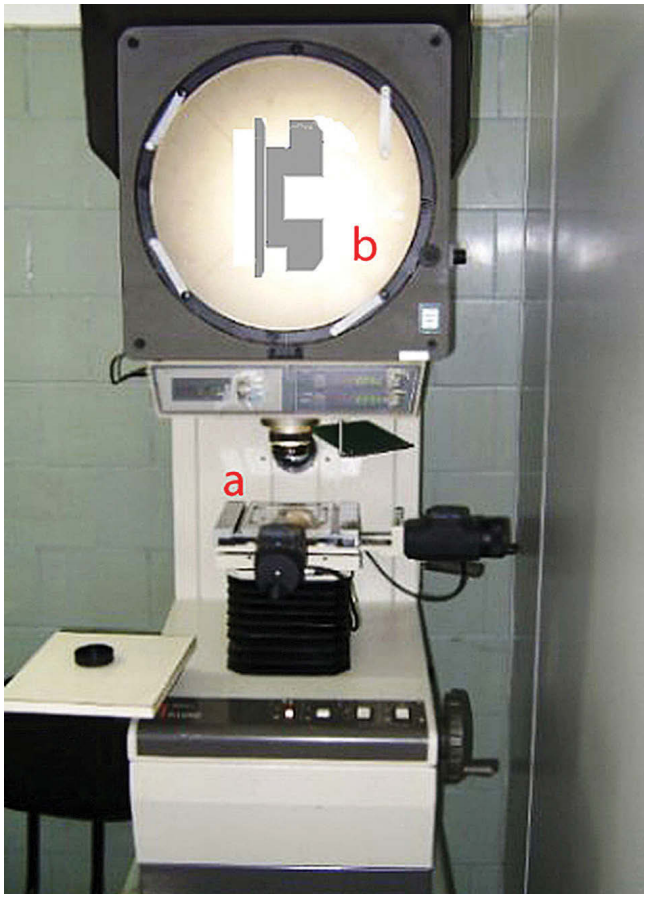


Figure 2 - Profile projector. (**a**) Once the brackets were correctly positioned on this device, their shadows were projected with a substantial magnification. (**b**) Bracket height and depth were measured.

The analysis of the wire dimensions was performed using a profile projector (Nikkon V16, Japan). For the measurement of both sections of the wire, the segments were observed in frontal and profile views. After projection of the wire shadows, their height and depth were measured.

c) Surface characteristics analysis of brackets and wires

Bracket and wires surface characteristic analysis was performed by SEM at a magnification of 1000x (Fig 3). Initially, a point above the mesial gingival tie-wing of the bracket slot and a point in the center of the wire segment were pre-determined. The images taken were recorded, identified and randomly distributed in the Microsoft Office Power Point 2010 software,. Subsequently, the images were analyzed by two examiners, using a discrete scale quantitative classification containing four scores: 0 – very rough surface; 1 – rough surface; 2 – smooth surface; and 3 – very smooth surface. Twenty per cent of samples from each group were re-evaluated, in order to verify conformity between examiners.

Table 2 - Description of studied wires.

Manufacturer	Dimension	Alloy
3M/Unitek (3M)	0.019 x 0.025-in	Stainless steel
Dental Morelli (MO)	0.019 x 0.025-in	(Fe, Ni, Cr)*

* Composition of stainless steel. Source: Anusavice[7] (1996).

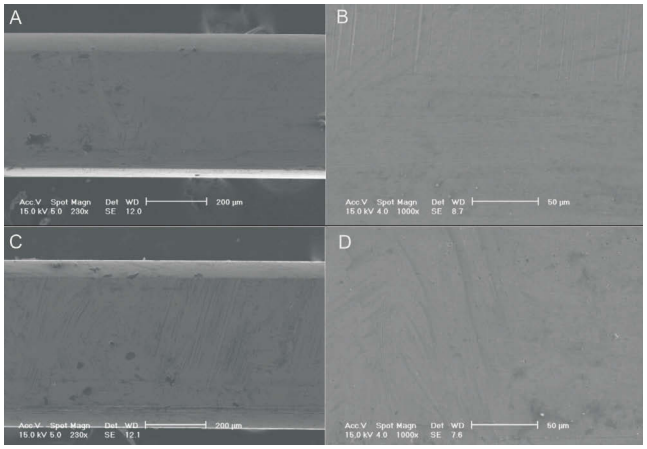


Figure 3 - Scanning Electron Microscopy of wires. (**A**) 3M-Unitek wires - Group IV –at a magnification of 230x and (**B**) 1000x; (**C**) Morelli wires at a magnification of 230x and (**D**) 1000x.

d) Wire surface roughness analysis

Roughness of wires was evaluated with a surface roughness tester (Mitotoyo SJ201, USA). After cleaning, the wire segments were stuck to a flat table using dental wax, where the roughness tests were carried out. Each wire was rated five times in different regions. Finally, the average values for each wire and different groups were calculated.

All tests were conducted in a climate-controlled environment and with controlled relative air humidity, avoiding any size change of the metal used for manufacturing orthodontic accessories.

e) Statistical analysis

Data normality was confirmed by the Kolmogorov-Smirnov test ($p > 0.05$) and the homogeneity of variances was tested by Levene's test ($p > 0.01$).The results associated with the sizes of the bracket slots were subjected to analysis of variance (ANOVA) followed by Tukey's test ($p > 0.05$). Student's *t* test was used for comparison between heights, depths and surface roughness of wires. The null hypothesis was tested by one-way ANOVA. The analysis of surface characteristics was performed descriptively. Inter-examiners agreement was evaluated by Kappa test and it was considered excellent (Kappa = 0.867). All tests were conducted with the Statistical Package for the Social Sciences, version 17.0 for Windows (SPSS, Chicago, IL, USA).

RESULTS

According to the SEM evaluation (Table 3), DYN/3M, STD/MO and Ni-Free/MO brackets showed slots with heights larger than those specified by the manufacturers ($p < 0.05$). The Ni-Free/MO bracket slots showed larger size, followed by DYN/3M and STD/MO brackets, respectively (Table 3). According to the PP method, there was no statistical difference between the slot heights measured in this study and the standard dimension specified by manufacturer, except for the Ni-Free/MO group (Table 3). On the other hand, regarding the slot depth, DYN/3M and Ni-Free/MO groups showed larger dimensions than those specified by the manufacturers. The comparison between groups did not indicate statistical differences (Table 4).

For the wire dimensions (SEM and PP), the DYN/3M group showed greater heights than that specified by the manufacturers, which was statistically different from the MO groups. With regard to the wire depth, there were no statistical differences (Table 5).

The analysis of surface characteristics of the bracket slots (SEM) showed a better metal polishing for the accessories of the DYN/3M group: 90% of the sample scored 3 and 10% scored 2; followed by the STD/MO group, which showed that 80% scored 1, 10% scored 2, and 10% scored 0. With a more irregular surface characteristic, Ni-Free/MO accessories showed that 40% scored 0 and 60% scored 1.

For the wire segments, the visual surface analysis (SEM) indicated that the MO groups showed 17% scoring 3 and 83% scoring 2. The 3M group showed 33% scoring 3 and 67% scoring 2. The surface roughness of wires indicated no significant differences between groups (Table 6).

DISCUSSION

SEM analysis indicated that the brackets of all groups presented slot height larger than 0.022-in (Table 3). It is important to emphasize that in the Ni-Free/MO group, the presence of changes in the slot conformation was observed, i.e., the height of the slots in the mesial and distal extremities showed greater sizes than those heights in internal extremities (medial), as can be seen in Figure 1.

Table 3 - Statistical analysis of the bracket slot heights (results in inches).

Method	Group	Mean	Median	SD	SE	MIN.	MAX.
MEV	DYN/3M*#	0.02396	0.02371	8.10×10^{-4}	2.8×10^{-4}	0.02251	0.02534
	STD/MO*#	0.02251	0.02252	4.3×10^{-4}	1.3×10^{-4}	0.02199	0.02335
	Ni-Free/MO*#	0.02570	0.02554	9.1×10^{-4}	2.8×10^{-4}	0.02438	0.02697
PP	DYN/3M	0.0223	0.0225	1.0×10^{-3}	3.3×10^{-4}	0.0210	0.0240
	STD/MO	0.02169	0.02185	6.9×10^{-4}	2.2×10^{-4}	0.0200	0.0225
	Ni-Free/MO*	0.02247	0.0223	5.2×10^{-4}	1.6×10^{-4}	0.0220	0.0232

n = 10 brackets (each group);
* = difference between slots dimension obtained (SEM and PP) and the manufacturer specified dimension (One sample t test, $p < 0.05$).
# = Statistical differences between groups (one way ANOVA,followed by Tukey test, $p < 0.05$).

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Table 4 - Statistical analysis of bracket slot depth (results in inches).

Method	Group	Mean	Median	SD	SE	MIN.	MAX.
PP	DYN/3M*	0.0308	0.0310	1.3×10^{-3}	4.1×10^{-4}	0.0290	0.0330
	STD/MO	0.02892	0.02935	3.1×10^{-3}	9.9×10^{-4}	0.0250	0.0350
	Ni-Free/MO*	0.0290	0.0290	9.4×10^{-4}	2.9×10^{-4}	0.0280	0.0310

* = difference between bracket dimension obtained (PP) and the manufacturer specified dimension (One sample *t* test, $p < 0.05$).
# = Statistical differences between groups (one way ANOVA, followed by Tukey test, $p < 0.05$).

Table 5 - Height and depth comparison between studied wires (results in inches).

	Manufacturer	Mean	Median	SD	SE	MIN.	MAX.
Wires' height	3M*#	0.01967	0.02200	5.1×10^{-4}	2.1×10^{-4}	0.0190	0.0240
	MO#	0.02072	0.02200	1.8×10^{-3}	7.4×10^{-4}	0.0190	0.0240
	Brand	**Mean**	**Median**	**SD**	**SE**	**MIN.**	**MAX.**
Wires' depth	3M	0.0250	0.0250	6.3×10^{-4}	2.5×10^{-4}	0.0240	0.0260
	MO	0.02457	0.0245	9.4×10^{-4}	3.8×10^{-4}	0.0234	0.0260

* = difference between wire dimension obtained and the manufacturer specified dimension (One Sample *t* test, $p < 0.05$).
# = Statistical differences between Groups (one way ANOVA, followed by Tukey test, $p < 0.05$).

Table 6 -Statistical analysis of wire roughness (results in micrometers).

Manufacturer	Mean	Median	SD	SE	MIN.	MAX.
3M	0.0360	0.0330	1.1×10^{-2}	3.3×10^{-3}	0.0200	0.0640
MO	0.04483	0.0390	1.5×10^{-2}	4.6×10^{-3}	0.0320	0.0880

Thus, the Ni-Free/MO group showed a vertical size of the slots statistically larger than the other groups, followed by the accessories of DYN/3M and STD/MO groups, respectively. Assad-Loss et al[8] also observed rounding of the exterior angle of the brackets slots. Cash et al,[9] when assessing the size and geometry of bracket slots that belonged to 11 different trademarks, concluded that all analyzed accessories showed greater slots than those specified by the manufacturers, confirming the findings of this study.

On the other hand, when the profile projector was used to measure the slot height in this study, no statistical differences were found between the groups. Only accessories from the Ni-Free/MO group showed a significant greater height than that specified by the manufacturers. It should be noted that this method is based on linear measurements from the projection of the shadow of a piece (Fig 2). Therefore, a superimposition of the shadow of the middle region of the slot on the shadow of the lateral region is unavoidable, which can mask the conformation change of the slots observed by SEM from a front view (Fig 1). In this way, it must be considered that the PP methodology does not take into account possible variations in the vertical size of the slots, i.e., the measurement value obtained expresses the smaller vertical size of the bracket slots. This fact makes PP results found for the Ni-Free/MO group more relevant, since accessories of this group showed slot height significantly larger than that specified by the manufacturers (Table 3).

The analysis of the slot depth (PP) did not indicate differences between groups, as the DYN/3M group presented the highest average, followed by the Ni-Free/MO and STD/MO groups respectively. It should be noted that the Ni-Free/MO and DYN/3M groups showed slot depth greater than that specified by the manufacturers. This lack of standardization of size and geometry of bracket slots has been reported by several authors.[3,8,9,26] Kusy and Whitley[2] assessed 24 brackets of different trademarks and found that three brackets had slots that were smaller than specified, while 20 others had slots larger than specified.

Assad-Loss et al[8] studied nine types of brackets of five different trademarks, concluding that there were differences between the slot height and depth when compared with the standard announced by the manufacturer. Onthe other hand, Astrid et al[26] analyzed the sizes of brackets

and wires of different trademarks and concluded that the brackets studied showed standardized sizes, while some wires were outside the expected standard.

Regarding the size of the wires, statistical differences between the 3M and MO groups were observed in this study (Table 5). It is interesting to note that the 3M group showed an average height statistically different from that specified by the manufacturers. Regarding the MO group, a wide variety of wire sizes was observed, which indicates a smaller standardization of wires belonging to this group. Professionals must be aware of the possible clinical disadvantages that represent these results. Several authors confirm the direct relationship between the diameter/section of wires and frictional force.[2,10-15] Nanda and Ghosh[2] state that the size and shape of wires and the height and depth of the slots of the brackets are factors that can affect the friction force during sliding mechanics. Kapur, Sinha and Nanda[15] observed that the frictional resistance of stainless steel brackets was higher with increasing diameter/section of the wire.

The qualitative analysis of slot surface characteristics obtained in this study points to the fact that DYN/3M brackets have greater homogeneity of the metal matrix, followed by brackets from STD/MOR and Ni-Free/MOR groups, which confirm previous studies.[17,19] Some authors have reported minor frictional forces during the sliding mechanics on accessories that have slots with smoother surface[18,19] and this fact is an area of controversial discussion.[20] Also, it should be noted that the superficial homogeneity of metal alloy constituent of orthodontic accessories is an important factor in the prevention of the corrosive process, which has become a topic of interest in orthodontic literature.[6]

The qualitative analysis of surface characteristics of wires showed no significant differences between the groups studied (Fig 3), which is a result that was confirmed by the analysis of roughness (Table 6). This consistency between the results obtained by the two different methodologies (SEM and the Roughness Tester) confirms the effectiveness of visual analysis regarding surface characteristics by means of Scanning Electron Microscopy, in accordance with the findings of Menezes et al[17] and Chappard et al.[23]

The standardization of bracket slot sizes seems essential to consolidate certain technological advances, such as the clinical option of using the straight wire technique. Such decision is usually based on angular values that vary according to the chosen prescription and, theoretically, manufacturers should establish such values with precision. This research considers the evident lack of standardization of these accessories during manufacturing process, which may be clinically associated with undesirable changes in tooth positioning and movement. Therefore, it is suggested to conduct studies that investigate this lack of standardization of torque and angulations as specified by the manufacturers for straight-wire brackets with different prescriptions. In addition, it is necessary to understand possible determining factors of this remarkable lack of standardization of orthodontic accessories, such as their constituent alloy and/or their manufacturing processes.

CONCLUSIONS

Based on the results of this study, it can be concluded that:

- There was no standardization in the manufacturing process of orthodontic brackets belonging to the groups DYN/3M, STD/MO and Ni-Free/MO, which showed a significant increase in the average height of their brackets slots;
- Regarding the wire sizes, the DYN/3M group presented a greater height than that specified by the manufacturers, unlike MO group;
- The Ni-Free/MO bracket group showed less homogeneity of the metal matrix, followed by STD/MO and DYN/3M groups, respectively.

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Shear bond strength of metallic and ceramic brackets using color change adhesives

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Objective: To determine the shear bond strength of orthodontic brackets using color change adhesives that are supposed to aid in removing excess of bonding material and compare them to a traditional adhesives.

Methods: Ninety metallic and ninety ceramic brackets were bonded to bovine incisors using two color change adhesives and a regular one. A tensile stress was applied by a universal testing machine. The teeth were observed in a microscope after debonding in order to determine the Adhesive Remnant Index (ARI).

Results: The statistical analysis (ANOVA, Tukey, and Kruskall-Wallis tests) demonstrated that the mean bond strength presented no difference when metallic and ceramic brackets were compared but the bond resistance values were significantly different for the three adhesives used. The most common ARI outcome was the entire adhesive remaining on the enamel.

Conclusions: The bond strength was similar for metallic and ceramic brackets when the same adhesive system was used. ARI scores demonstrated that bonding with these adhesives is safe even when ceramic brackets were used. On the other hand, bond strength was too low for orthodontic purposes when Ortho Lite Cure was used.

Keywords: Orthodontic brackets. Dental materials. Adhesives.

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INTRODUCTION

Brackets bonding on tooth enamel is one of the most important procedures in orthodontic practice. The adhesive force should be enough to keep the bracket in position throughout the orthodontic treatment, but not strong enough to cause damage on its debonding. Lopez,[14] as well as Reynolds,[21] suggests that shear strength should be 6-8 MPa. Equivalent traction would be about 5 MPa.[1] This adhesive force would be clinically effective and would minimize the risk of enamel fracture. Unions stronger than 14 MPa can be disastrous to human enamel.[20]

Bonding strength depends on the design of the bracket base, the adhesive used, the bonding technique, the adhesive thickness, the bracket geometry and experience of the professional.[2,6,8,23] Experimental procedures used in the test brackets may affect the results.[12] Bonding force may vary according to the material used in manufacturing the bracket. Currently, the use of ceramic brackets is becoming increasingly common as more patients seek esthetic appearance.[5] Unfortunately, the bond strength between ceramic brackets and enamel can be very high, causing damage to the enamel during debonding.[4]

Besides the adhesive strength, while fixing orthodontic appliances, it is important to consider that they may increase the accumulation of dental plaque, enabling the development of gingival inflammation and carious lesions.[10,16] In a short period of 3 months, orthodontic appliances can alter the subgingival microbiota.[16] Thus, removal of any excess of adhesive material around the bracket is highly recommended. It is sometimes difficult to remove all material since the color of resins is very similar to enamel. Recently, colored resins that aid in the removal of excess material were introduced in the orthodontic market. These adhesives lose their color after polymerization.

The objective of this study is to evaluate the tensile strength of metal and ceramic brackets when two colored resins and a traditional one are used.

MATERIAL AND METHODS

Ninety metallic brackets (Morelli, Sorocaba, SP, Brazil) and 90 ceramic brackets (Virage, American Orthodontics, Sheboygan, WI, USA) were bonded in the center of the buccal surface of the lower incisors of healthy bovines, according to the manufacturer's instructions. Next, the teeth were placed in plastic tubes which were filled with acrylic resin.

The teeth were randomly divided into 6 groups: Group 1 (G1) = metallic brackets bonded with Ortho Lite Cure (Orthosource, N. Hollywood, CA, USA); Group 2 (G2) = ceramic brackets bonded with Ortho Lite Cure; Group 3 (G3) = metallic brackets bonded with Transbond Color Change (3M, Monrovia, CA, USA); Group 4 (G4) = ceramic brackets bonded using Transbond Color Change; Group 5 (G5) = metallic brackets bonded with Transbond XT (3M, Monrovia, CA, USA); and Group 6 (G6) = ceramic brackets bonded with Transbond XT. All teeth received prophylactic pumice stone and rubber cup for 10 seconds, washed and dried, etched with 37 % phosphoric acid according to the manufacturer's recommendations, then the primer was applied. The resin was applied at the base of the bracket and the same were placed in the center of the buccal surface of the teeth with slight hand pressure. The excess material was removed with an explorer probe. In G1, the adhesive was polymerized for 20 seconds on incisal and lingual aspects. In G2, the cure time was 20 seconds on the buccal aspect. In G3 and G5, the polymerization time was 10 seconds on mesial and distal on each bracket. In G4 and G6, the cure time was 10 seconds applied to the buccal surface. After the bonding procedure, the samples were stored in a closed container with 100% relative humidity at 23 °C for one hour and then immersed in distilled water for 23 hours.

The samples were tensioned with two segments of 0.010-in orthodontic wire tied on proximal wing and bent in the central region of the buccal surface to apply force perpendicular to the base of the bracket. The opposite end of the wire was connected to a universal testing machine (Applied Test Systems®, ATS-1105c, Butler, PA, USA). Displacement rate used was 0.5 mm/min. After bonding, all samples were analyzed by optical microscope (Olympus S7CTV, Center Valley, PA, USA) with a magnification of 10X to evaluate the adhesive remnant index (ARI) according to Artun and Bergland[3] (Table 1). To illustrate the debonding pattern, photographs taken with the optical microscope with a 20X magnification were made (Fig 1).

Statistical analysis was performed using SPSS® 10.0 software. To verify the normality of the data, we used the Kolmogorov-Smirnov test. In order to

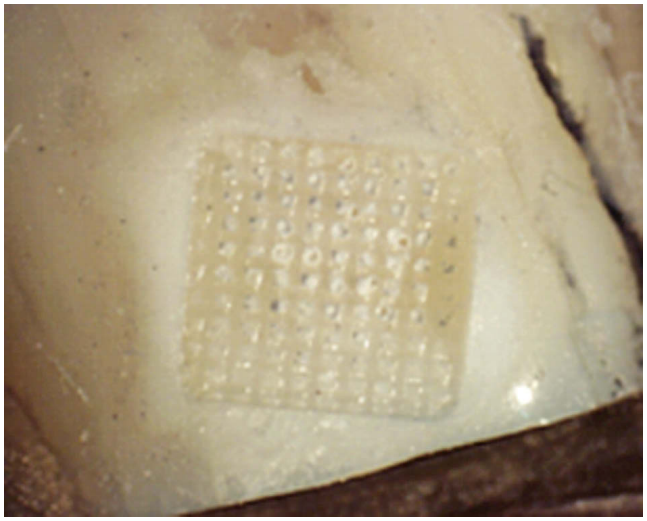


Figure 1 - Illustration of the ARI score 3 (20X magnification).

Table 1 - Adhesive remnant index (ARI).

Score	Quantity of adhesive bonded to enamel
0	No adhesive left on the tooth
1	Less than half of the adhesive left on the tooth
2	More than half of the adhesive left on the tooth
3	All adhesive left on the tooth with a distinct impression of the bracket mesh

Table 2 - Comparison of bond strength (MPa) between the groups ($p < 0.01$).

Group	n	Mean*	SD
G1	25	2.47[a]	1.66
G2	30	2.75[a]	1.64
G3	30	4.26[b]	1.20
G4	25	4.22[b]	1.12
G5	30	5.62[c]	0.75
G6	30	5.95[c]	0.91

* Different letters represent statistical difference ($p < 0.01$).

Table 3 - ARI comparison between groups.

Group	Index 0		Index 2		Index 3		Total	
	n	%	n	%	n	%	n	%
G1	5	20.0	2	8.0	18	72.0	25	100.0
G2	8	26.6	4	13.3	18	60	30	100.0
G3	1	3.3	6	20	23	76.6	30	100.0
G4	-	-	4	13.3	21	70	25	100.0
G5	2	6.6	5	16.6	23	76.6	30	100.0
G6	1	3.3	3	10	26	86.6	30	100.0
Total	17	10	24	14.11	129	75.88	170	100.0

compare the results of the bond strength, analysis of variance (ANOVA) and the Tukey test were used. To compare the results of the ARI between different groups it was used the Kruskal-Wallis test.

RESULTS

The results of this study are shown in Tables 2 and 3. In G1 and G4, five specimens were excluded because of discrepancies in the obtained values.

The results show no statistical difference between the groups where the same adhesive was used for bonding ceramic and metallic brackets. However, there was significant difference between the three brands of adhesive used. The groups bonded with Transbond XT (G5 and G6) showed the highest adhesion, followed by the groups bonded with Transbond Color Change (G3 and G4). The worst results were obtained with the Ortho Lite Cure resin (G1 and G2). The results for the ARI showed no significant difference between the groups and the most frequent result was the resin completely bonded to enamel surface after debonding (Fig 1).

DISCUSSION

The bond strength between brackets and enamel has been extensively researched over the past two decades. However, some issues still persist for the choice of adhesive by the orthodontist, especially due to the large amount of materials available in the market. The main issues fall back on the safety of the procedure, cost-benefit and efficacy of the product. Plaque accumulation around the brackets is an important issue, since the orthodontic appliances may be responsible for caries and gingival disease.[2,17] Thus, the colored adhesives can be an important tool in reducing the excess of material and dental plaque.

In the present study, when the results of the ARI are evaluated, we note that for all groups the most common result was the score 3, where all the adhesive remains in the enamel after debonding. Olsen et al[18] reported that the ARI index 3 is the safest, where the chance of dental damage is less likely. Therefore, we can conclude that the tensile strength obtained with both resins, traditional and colored, is safe.

When the bond strength is analyzed, it can be concluded that there was no differences between metallic and ceramic brackets when the same adhesive

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was used, which gives the orthodontist the possibility to safely bond ceramic brackets. This fact brings tranquility, due to the increasing demand for esthetic orthodontic brackets in clinics. The bond strength obtained in G1 and G2 was too low to orthodontic use.[9,14,19] The adhesive strength for G3 and G4 was a bit low for bonding orthodontic accessories, but it was acceptable.[22] The tensile strength shown in G5 and G6 was adequate according to Aasrum et al.[1] However, while Reynolds[21] recommends shear strength of 7 MPa, he also relates the difficulty of establishing the optimal adhesive strength between bracket and tooth enamel. Other studies have also demonstrated the difficulty of establishing a numerical value for bonding strength when it depends on many factors such as experimental procedures,[11] adhesive thickness,[8] bonding procedures,[6] type of adhesive used,[2,18] and the direction and type of applied force,[13] and other factors. Therefore, the comparison of results becomes difficult. This raises some questions as: Are we basing our clinical choices properly, or should further studies be conducted to clarify these issues? Murray and Hobson[15] as well as Eliades et al,[7] report the difficulty of comparing the results obtained in *in vitro* tests to the *in vivo* reality. According to these authors, methods for assessing the influence of the environment on intraoral adhesive strength of brackets to enamel should also be developed. The discrepancy between the results of this study and the results reported in the literature may be due to the different methodologies used, but probably the presence of colored pigments in orthodontic resins must reduce the bond strength of these materials.

A clinical observation noticed by the operator was that the Ortho Lite Cure orange pigment does not differentiate from tooth enamel color and it is not very useful in removing the excess of material. The pigments present in the Color Change Transbond are quite distinct from enamel and assist in the removal of resin excess, but their sandy consistency is not very pleasant to work with.

Further studies with these materials must be conducted to obtain more information about the shear strength. The impact of these adhesives on plaque accumulation must also be thoroughly investigated in order to determine whether or not they have a positive effect on plaque reduction during orthodontic treatment. Since these adhesives are more expensive than traditional ones, the benefits should be significant. It is recommended that more studies be conducted to investigate the ideal adhesion strength of orthodontic accessories in human enamel.

CONCLUSIONS

The results of this study demonstrated:

a) Tensile strengths of metallic and ceramic brackets were similar when the same adhesive was used.

b) Transbond XT adhesive had the highest bond strength, followed by Transbond Color Change adhesive, which presented clinically acceptable resistance values.

c) The worst results in terms of tensile strength were obtained with the Ortho Lite Cure adhesives, which were considered low for orthodontic use.

d) Further studies must be conducted on the clinical use of colored adhesives.

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Assessment of motivation, expectations and satisfaction of adult patients submitted to orthodontic treatment

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Objective: The purpose of this study was to analyze the psychological aspects of adult patients who sought and underwent orthodontic treatment, evaluating their expectations and discomfort during treatment, as well as their satisfaction after completion of dental movement.

Results and Conclusions: Data obtained from previous published papers, and also from questionnaires answered by 54 patients, showed that adult patients stood out for their attention to details and high interest in the esthetic improvements provided by treatment, and also for a greater perception of their initial malocclusion. On the other hand, the same data showed that adult patients, once informed about the limitations of their treatment and having confidence on the orthodontist, presented a high level of satisfaction with treatment results, revealing themselves as good patients for indication and execution of orthodontic procedures.

Keywords: Orthodontics. Psychology. Behavior. Adults.

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INTRODUCTION

Many authors confirm what orthodontists have been noticing on a daily basis in their private practices: The increasing number of adult patients seeking orthodontic treatment.[3,4,6]

When planning orthodontic treatment for patients in that scope, we should bear in mind that, generally, adults present a different experience in relation to buccal pathologies, and psychological limitations when compared to teenagers and children.

Focusing in the psychological aspects concerning adult patients, many studies prove that these patients have a greater awareness of their malocclusion, which may generate very optimistic expectations about the final results of their treatment.[4,10,11] In search for delivering a more efficient treatment to such patients, it is mandatory that orthodontists investigate and understand the expectations, difficulties, and motivations of this increasing group, in order to offer assistance that matches their concerns.

The offer of orthodontic treatment to adult patients, albeit becoming more common in the last decades, is not a product of our time. The first reference to it was made by Pierre Fauchard, author of the first scientific Dentistry book known to us as Le Chirurgien Dentiste from 1723.[6]

Epidemiologic data that has been gathered since the 80's confirms the increase of the demand of patients in that age group (18 +) who want and need orthodontic treatment. In the United States, in 1988, it became clear that in large urban business centers, this demand represented between 60 to 70% of all the patients looking for treatment. In Europe, studies from the beginning of the 80's also show an increase in adult patients seeking orthodontic care.[6,11]

Recent studies show that the frequency of malocclusion in adults is similar, if not higher to that observed in children and teenagers. According to official data released by the North American government in the NHANES III (Third National Health and Nutrition Survey), in the 90's, only 41.1% of all American adults had an optimal overjet, 49% presented deep bite, 3.3% open bite, and there was also a significant occurrence of misalignment in upper and lower incisors, respectively 56% and 62.9%.[3,12] In a similar way, the prevalence of malocclusion in Eastern Europe adults, according to studies conducted within populations from Germany and Sweden, reached between 40 and 76% of the total adult population from these regions.[3]

In 2003, a study made with 200 adult patients, evaluated the reasons which led them to initially reject the suggestion to undergo orthodontic treatment. The researchers found out the reasons to be, from the highest to the lowest prevalence: Long treatment time, the discomfort of wearing orthodontic appliances, rejection to the anti-esthetic appearance of brackets, concerns about pain, and fear of disappointment with the final treatment result.[7]

Within the large demand of adult patients who seek and need orthodontic assistance, literature has shown that most of these patients are females,[6,10] and that the indication for them to seek for an orthodontist comes from the family dentist.[6]

Just like every health related treatment, orthodontic treatment in adults has its indications and contraindications, which must be carefully assessed before any action takes place.

Highlighted among the indications are: The possibility of improving teeth implantation in the periodontal tissues, determining a more stable and harmonious occlusive pattern, distribution of edentulous spaces so that they can be restored later, improvement of the occlusal condition and protection of the stomatognathic system (especially the temporomandibular joint - TMJ) and satisfaction of the patients esthetical demands.

The cases where orthodontic treatment would be contraindicated in adult patients are: Existence of severe skeletal discrepancies (in these cases surgical treatment would be preferable), patients with systemic or advanced local diseases, cases of severe alveolar bone loss, when the results might not fulfill the expectations of both the patient and the professional in charge of the treatment, questionable prognostic stability, and lack of patient interest or motivation.[13]

The main reason that leads adult individuals to search for orthodontic care is their dissatisfaction with their dental and/or facial appearance; and many studies confirm that adult patients have greater perception of their dental esthetics thus presenting higher demands concerning the results achieved after orthodontic therapy.[4,5,6,9] Another frequent reason is the need for isolated dental movements so that other procedures aiming the control of periodontal disease prosthetic rehabilitation (implants or prosthesis), or cosmetic (dental reconstructions) can be executed within a multidisciplinary planning.[6]

Previous studies that proposed to evaluate the psychological profile of adult patients seeking orthodontic

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treatment showed that many of these patients presented a neurotic or unstable psychological profile along with problems of self-esteem. These same studies alert orthodontists that this kind of patient tends to nurture great expectations, some of them even being unreal, regarding treatment results, and suggesting that the tangible results should be made as clear as possible to them in order to avoid future disappointments.[4,10,11]

In 2005, researchers gave a satisfaction questionnaire to be answered by 100 patients treated in the Academic Center of Dentistry in Amsterdam three years after they completed their orthodontic treatment. In that study it was observed that the most important issue in determining patient satisfaction was the good orthodontist/patient relationship during treatment and that female patients revealed lower satisfaction levels with the dentofacial improvements achieved by treatment when compared to male patients.

The objective of the present study was to analyze, through questionnaires the psychological profile of adult patients, most of them living in the city of Goiânia/GO, Brazil, who underwent orthodontic treatment, assessing their expectations, discomfort during treatment, and final satisfaction after completion of the dental movements, in order to serve as a guideline for orthodontists during planning and executing their clinical treatment focusing on the satisfaction of their patients, minimizing their discomfort, and establishing special procedure protocols for such patients.

MATERIAL AND METHODS

The material used in the present study was a set of 54 questionnaires given to adult patients, most of them residents in the city of Goiânia/GO (Brazil), who had received orthodontic treatment from dentists specialized in orthodontics living in that same city. Among the selected patients, 12 had completed their treatment at the Orthodontics Specialization Program Clinic at the ABO-GO and 42 had been treated in private practices of orthodontists registered in the Regional Dental Council (CRO) as specialists.

The patients were selected according to the following inclusion criteria: 1 – completion of orthodontic treatment; 2 – Submitted to only one corrective orthodontic treatment; 3 – Treatment initiated after reaching the age of 20 years; 4 – Orthodontic treatment did not involve orthognathic surgical procedures; 5 – Absence of any health problem that could influence in the orthodontic treatment.

Once selected, the patients were contacted by phone and were motivated to come either to the Orthodontics Specialization Program Clinic at the ABO-GO (patients who had been treated at that institution) or to the private practice of their respective orthodontists.

Concerning gender, 40 female patients and 14 male patients were evaluated (Fig 1).

The age which the patients started treatment ranged from 20 up to 61 years old, being that 29 of them started treatment in their second decade of life, 12 in their third decade of life, 07 in their fourth, and 06 after being 50 years old (Fig 2).

At the moment each patient arrived to the practice, they were given the Informed Consent and after signing it, they all answered a questionnaire with 9 objective questions concerning the topic that was being investigating. The questions were tailored so that they could answer them fast and objectively, and some blank space was given so that they could include personal considerations.

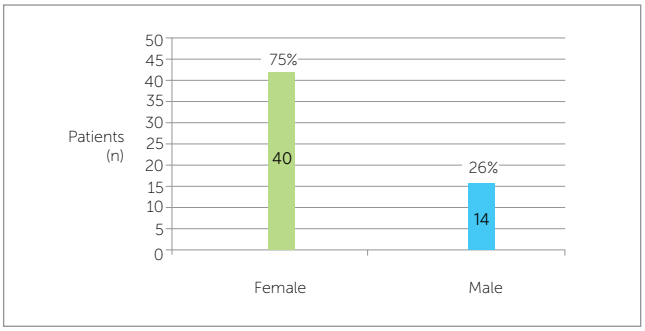


Figure 1 - Distribution of the sample by gender.

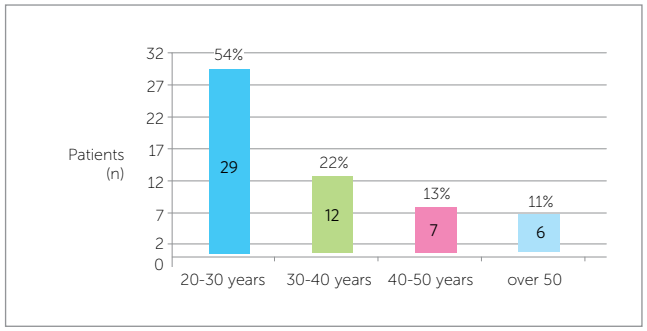


Figure 2 - Distribution of the sample according to the age at the beginning of the performed orthodontic treatment.

The data contained in the questionnaires were classified and transformed into tables and descriptive statistics were made.

RESULTS

Assessment of the answers to the questionnaire.

When the patients were asked about the reason for them to seek treatment only when adults, the answers were: 31% for a previous lack of financial means; 30% were not previously bothered with the position of their teeth; 14% looked for treatment after being told (insistently) by their general dentists; 9% said they didn't know orthodontics could solve their dental problems; 2% believed orthodontic treatment was only suitable for teenagers and children, and 14% mentioned other reasons, and among these we found: The wish and the need of a better facial look, the need of preparation for dental implants, speech therapist recommendation, and TMJ discomfort (Fig 3).

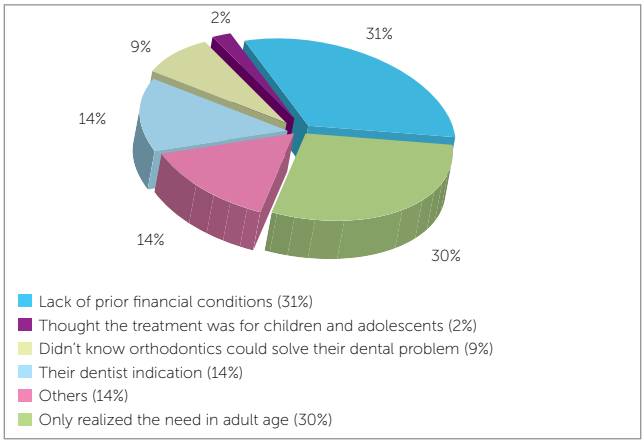


Figure 3 - Reasons that led patients to seek orthodontic treatment only in adult age.

Trying to assess the perception of malocclusion, before the beginning of orthodontic treatment, the patients informed that the aspects that were most annoying them were: The poor appearance of the smile, 36 patients (61%); 09 patients pointed to problems with chewing (15.2%); 08 patients pointed to the empty spaces due to tooth loss (13.5%); 04 pointed to periodontal problems (inflammation, tooth mobility) corresponding to 6.7% of the answers; and 02 pointed to difficulty in speaking (3.3%), being that 05 out of the 54 patients marked 2 answers to this question (Table 1).

When answering about the reasons for rejecting the initial indication to undergo orthodontic care, the answers were: 55.3% felt concerned with the perspective of the long duration of treatment; 17.8% had doubts about the true efficiency of orthodontic intervention; 12.5% were afraid of feeling pain during treatment; 10.7% rejected the unpleasant appearance of braces; and 3.5% said they had never rejected the idea of undergoing an orthodontic treatment (Table 2).

In relation to the reasons which led the patients to make the choice for receiving orthodontic treatment it was found that: 35.5% said about the suggestion of a general dentist; 27.1% already wanted to undergo treatment; 22% made up their minds after talking to an orthodontist; 11.8% told they were influenced by the opinion of their relatives and friends; and 3.3% mentioned different reasons, such as the opportunity to avoid a possible orthognathic surgery and the wish to receive dental implants afterwards. The data referring to the previous question are available on Table 3, and each patient could check more than one answer.

Regarding the discomforts experienced throughout treatment, 22 patients complained of pain after activation appointments (40%); 13 complained about the long time of active treatment (23.6%); 09 patients (16.3% from the total) claimed they hadn't felt any discomfort during orthodontic treatment; 06 pointed to difficulties in dental hygiene and flossing, associated with wounds on their inner cheeks, as the main reason for discomfort (10.9%); 03 people were concerned about the unpleasant look of their braces (5.4%); 01 patient complained about periodontal inflammations linked to the treatment (1.8%); 1 complaint about recurrent aphthous lesions during treatment, and none felt embarrassed about being among much younger patients at the orthodontic practice environment (Table 4).

The most important positive change observed by patients after treatment conclusion was: The improvement of facial appearance for 39 patients (72.2%); 13 noticed changes in their chewing and/or speaking pattern (24%); 07 reported improvements in their periodontal conditions along with a better implantation of their teeth (12.9%); 01 patient checked all the answers above and 08 checked two answers (Table 5).

When comparing the actual results obtained with the pre-treatment expectations: 50% considered the obtained results to be better than what they had expected; for 46.2% the results were similar to what they had expected; 3.7% considered that their expectations

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Table 1 - Patients perception of their smile, prior to orthodontic treatment.

Before the treatment, what was your chief complaint about your teeth?	
Bad esthetics	36
Mastication problems	09
Edentulous space (closed during treatment)	08
Gingival problems (inflammations, tooth mobility)	04
Speaking problems	02
Number of patients that checked two answers	05

Table 2 - Reasons most mentioned for initial rejection of the treatment suggested.

What was bothering the most in the orthodontic treatment idea?	
Long duration	31
Doubts on the treatment efficiency	10
Fear of feeling pain	07
Unaesthetic aspect of the appliance	06
Nothing	02
Number of patients that checked two answers	05

Table 3 - Determining factor in deciding for starting the treatment.

What made you start the orthodontic treatment?	
Dentist orientation	21
You wanted already to receive the treatment	16
Chat with the orthodontist	13
Opinion and support from family, spouse and friends	07
Others (avoid orthognathic surgery, implants need)	02

Table 4 - Main discomfort brought by the treatment.

During treatment, what most displeased you?	
Pain during and after activation sessions	22
Found the treatment too long	13
Nothing	09
Difficulty in cleaning and wounds in the mucosa.	07
Felt embarrassed with the appearance with appliance	03
Gingiva inflammation	01
Recurrent ulcer	01
Embarrassment in contact with children and adolescents	00

Table 5 - Subjective perception of patients front orthodontic treatment results.

After treatment, which motivation did you noticed more?	
More beautiful smile (facial esthetic improvement)	39
Speech and mastication pattern improvement	13
Gingival and tooth implantation condition improvement	07
Others	04

Note: A patient marked all the answers and eight others marked two answers.

before treatment were fairly achieved; and none of them considered the treatment results to be inferior to their initial expectations.

In a question aiming to know if they would undergo orthodontic treatment again, it was concluded that 100% of patients did not regret undergoing it, and all of them said they would, based on their personal experience, encourage other adults to go through orthodontic treatment if necessary

DISCUSSION

This study consisted in the subjective evaluation of 54 adult patients in the fixed retention stage. The predominance of female patients (74%) is consistent with data found in previous studies that suggested that women have a greater motivation to undergo orthodontic treatment when compared to men.

As seen in the results, when questioned about the reasons that led them to look for orthodontic assistance for the first time when in a more advanced age, the most common answers were the following in order of importance: 31.5% showed a previous lack of financial means; 29.8% reported that the awareness of the need for orthodontic treatment only raised at adult age. The high relevance of treatment costs seen in this local sample shows that this specific population has serious financial constraints, which sometimes may prevent them from gaining access to better health and well-being conditions.

When assessing the chief concern of adult patients who sought late orthodontic treatment, it is clear that most of the patients had esthetic reasons (61%). This data corroborates with previous studies that show that the great majority of patients seek treatment to improve their smile esthetics and their facial esthetics.[2,8]

A previous study also evaluated the reasons that led some adult patients to initially reject the indication for orthodontic treatment and found the following reasons, in relevance order: Long duration of the proposed treatment; discomfort caused by the braces, rejection to the anti-esthetic look of brackets, fear of pain, and the fear of disappointment with the final results.[7] When comparing the results achieved in this research with those of the one mentioned above, it is possible to observe in general, that patients showed similar doubts and concerns.

Among the factors indicated as determinant for the beginning of treatment were: A previous will to undergo it (27.1% of the patients), which shows a good acceptance of

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adults when confronted with the indication for orthodontic treatment; 22% decided only after consulting with an orthodontist, which also highlights the importance of a good professional/patient relationship, and 11.8% made the decision influenced by spouses, friends and relatives.

In relation to the main discomforts experienced throughout the active treatment, the majority of patients complained about pain during treatment and immediately after the activation sessions (40%); some complained about the long period of treatment (23.6%); and 16.3% said they did not feel any discomfort or constraint. In previous studies, patients highlighted discomfort as the worst aspect of orthodontic treatment, although classifying this discomfort as mild and short lasting (with a duration average of 2 days after clinical activation of the appliances). In these same studies, orientation on the controlled use of painkillers and restriction in the ingestion of hard foods on the days following the activations were enough to significantly minimize the aforementioned discomfort.[2,3]

In a research made in 1981, all adult patients assessed, who were undergoing orthodontic care, considered the treatment advantageous despite the discomfort related to treatment; they did not regret having started it, and would suggest it to others who were in doubt about the cost-benefit ratio of orthodontic treatment.[13] Other authors also found high level of satisfaction in patients when faced with the results achieved through the orthodontic treatment performed.[3] These informations were also confirmed by the present study.

When evaluating the level of satisfaction of patients after treatment, it should be kept in mind that the analysis made by patients are based on subjective aspects and not technical ones, thus being under influence of different agents, such as, the kind of professional/patient relationship and variables such as gender. Another research in 2005 concluded that the most important aspect to affect the level of satisfaction of patients is not the final quality of the treatment done, but a good relationship between the patient and his orthodontist. According to that same research, women were more critical regarding treatment results, although in previous studies mentioned by these authors, men had shown to be more demanding and critical about the results of orthodontic treatment.

CONCLUSION

When assessing the characteristics of adult individuals that underwent orthodontic treatment, it was found that this group is mainly constituted by women, between 20 and 30 years old (53%) who were not satisfied, mainly, with their smile esthetics (61%).

When patients were asked about the reason for not seeking orthodontic treatment earlier, the great majority answered that they did not have financial conditions, or did not feel inconvenienced by the malocclusion they had. Unfortunately, the lack of economical conditions proved, at least in this set of Brazilian patients, to be a major restraint for them, having prevented their previous access to the facial and smile esthetics improvements they were longing for.

Individual clinical planning and clarity in procedures, previously discussed with patients, can minimize the main reasons for initial rejection from patients when faced with orthodontic treatment, which were: Aversion to the long duration of treatment (55.3%), doubts about the efficiency of treatment (17.8%), fear of pain (12.5%), and discomfort with the esthetical aspect of fixed braces (10.7%). A good relationship between the orthodontist, the general practitioner and other professionals involved with the patient, along with a clear and careful initial appointment can be considered decisive in making adult patients fell safe to effectively start orthodontic treatment.

Once the treatment is initiated, the information gathered suggests that orthodontists should be aware about reducing the discomfort felt during and after appliance activation appointments, which was a reason of complaint in 40% of the people interviewed; also to instruct their patients on dental hygiene techniques, and to elaborate a simplified treatment plan to reduce, according to the possibilities, the total treatment time (regarded as uncomfortably long for 23.6% of patients).

At last, when assessing patients already in retention, a high level of satisfaction was found for patients interviewed with regard to the final treatment results. This only shows that once patients are aware and clarified about the peculiar limitations of each clinical case, and when a trusting relationship between the patient and their orthodontist is established, adults are excellent candidates for orthodontic treatment.

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Expectations of orthodontic treatment in adults: The conduct in orthodontist/patient relationship

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Introduction: The high demand for orthodontic treatment, evidenced over the last few decades, has been justified mainly by the greater importance given to facial esthetics, influencing individual's self esteem. However, the professional frequently does not meet all the patient's expectations, for not establishing good communication and not knowing about the critical points during orthodontic treatment.

Objective: The aim of this study was to elucidate patients' desires and doubts regarding orthodontic treatment, by means of a survey applied to 60 adult patients.

Results: The analysis of results revealed that most individuals (38.3 %) noticed treatment success after its conclusion. Occlusion deviation was pointed out by 66.7 % as the main reason for seeking treatment, and esthetics ranked as second (with 48.3 %). Treatment time was considered within the prediction by 46.7% of the interviewees and the results were judged as very good by 43.3 %. The social relations of most participants were not affected by treatment (73.3 %). Also, 58.3 % of the interviewees reported pain as the main complaint and 53.3 % found it difficult to use dental floss. Most participants saw the orthodontist as a professional who was concerned about their health (76.7 %), and believed that he/she was more able to treat them (96.6 %) when compared with the general practitioner.

Conclusion: The orthodontist/patient relationship enables an understanding of the expectations regarding orthodontic treatment, resulting in greater motivation and cooperation, leading to a successful outcome.

Keywords: Orthodontics. Adults. Facial pain. Malocclusion. Dental esthetics.

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INTRODUCTION

The mouth represents the man's first organ of relation with the environment, enabling nutrition, the establishment of social relations through speech, and cognitive development of the individual. It is also a striking feature for individualization of human being, besides presenting esthetic value and mediating interpersonal events.[29] The face also represents a key element in personal attractiveness and development of self-esteem. Within the wide concept of health, which covers the psychosocial well-being, facial appearance may interfere in various areas of social relations, since facial deformities with negative social and psychological reflexes act on patients' self-confidence, perception of beauty, about external relations, and even on identification with professional success.[13] Besides, the difficulty in quantifying the welfare and incapability to conceptualize it in human societies generally involves the use of impregnated concepts of subjectivity.[15]

In recent decades, a high demand for orthodontic treatment in adults was observed.[3] This fact is due to the increased awareness by patients of the need for good oral health, enabling the patient to reach adulthood with a greater number of teeth in the mouth.[3] It also happens by the increase on esthetic requirement from society.[3,7,8,13,16] by the increased access to information for the public about orthodontic treatment, and by the technological advancements in the field of orthodontics.[3] However, some "dogmas" regarding orthodontic treatment such as lack of communication between the parties involved, expectations for different results from patient in relation to the professional's view and technical glitches persist among the population in general, resulting in failure or dissatisfaction with treatment.

Despite these functional problems being always expressed by changes in chewing, orofacial pain, disproportions of the facial skeleton, it is the esthetic complaints, in most cases, that stimulate these patients to seek orthodontic treatment. The relative importance of esthetics in current society is understood when analyzing the positive attributes associated with physical attractiveness.[1]

Four factors are considered important for the success or failure of orthodontic treatment in adults: (1) Motivation, the patient must first be interested and aware of their appearance. (2) Mobility; teeth may have progressive mobility and continuous migrations. (3) Limitations; health of the oral tissues must be good and at least three quarters of the teeth's roots should be surrounded by alveolar bone, and no evident root resorption. (4) Cooperation, the patient should follow the guidelines for use of removable and fixed appliances, maintaining a long period of retention, and the use of fixed prosthesis as permanent retention.[23]

Many adults did not have the opportunity to take an orthodontic treatment at a young age due to lack of information or lack of financial resources. However, the top reasons for treatment in adults are: Increased cooperation, caring for the device, maintaining better oral hygiene and compliance with the guidelines.[6] A direct approach should be used in adults to eliminate the patient's complaint, limited to regions of the dental arch with some esthetic and functional impairment.[3]

A comparison of patients' self-esteem in orthodontic treatment with the general population did not show variations, however facial and occlusal self-perception is higher in orthodontic patients than general population, which demonstrates a decreased facial and body self-image. Most of the time the orthodontic treatment in adults results in improved self-image, which justifies its performance, even for purely esthetic reasons.[28]

Knowing patients expectations regarding treatment in order to adapt them to the real therapeutic possibilities, considerably increases the chances of satisfaction with the final results. Besides, encouraging the participation of the patients in choosing the best treatment alternative will necessarily make them think better about their real intentions in treatment, making them co-responsible, and this will reflect positively on the professional-patient relation.[13] Otherwise, there might be dissatisfaction with the orthodontic therapy.[17]

Since some dental characteristics are more noticed than others, the patient's perception of their own problem may differ from the professional's perception of it, being essential for general dentists to engage in a dialogue with their patients before carrying out any intervention, ensuring a safer approach on the patient's complaints and more satisfactory results for both of them.[20]

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When analyzing the goals for orthodontic treatment among patients in general, it was found that both those undergoing therapy and others described their dentitions, and 82 % of those orthodontically treated immediately identified the photograph of their teeth. It is evident that young adults have a great awareness about their own occlusion, independent of orthodontic treatment, inferring to these patients the appreciation of a good therapy result and significance of professional goals.[5]

Therefore, it becomes essential to have a deeper understanding about the possible effects that the use of orthodontic appliances can cause in psychosocial relations of orthodontic patients in order to improve the results of orthodontic treatment, becoming the main objective of this study.

MATERIAL AND METHODS

A cross-sectional study was conducted in 2008 to assess expectations of adult patients in relation to orthodontic treatment, as well as to the responsible professional. The sample consisted of 60 students from the Southwest Bahia State University (UESB) randomly assigned. The inclusion criteria were students presenting ages between 18 and 25 years and had already undergone orthodontic treatment with fixed appliances or were in the final stages of treatment. Volunteers who did not properly complete the survey were excluded, leaving it incomplete or damaged, those who presented less than 1 year of treatment, and those in which treatment started before 18 years of age. In order to standardize the data, the period between the completion or abandonment of orthodontic treatment, and the time when the survey was applied in this study could not surpass three years.

The instrument of data collection was a survey composed of 10 closed-ended questions, drawn from a pilot study conducted at Southwest Bahia State University , in 2004. This pilot demonstrated the feasibility of this instrument, adjusting the questions according to data obtained in orthodontic literature for studies of this nature. The survey was conducted by a single researcher, impartial and committed to not interfere with spontaneous answers provided by volunteers within the period from January to December 2008.

The survey was formulated to include demographic aspects (gender and age), patient expectations in relation to orthodontic treatment and patient expectations in relation to the professional. So, after quantifying the data, the purpose was to determine the behavior, during planning and performance, that provided the qualitative deficiencies of orthodontic treatment.

The data were tabulated in a spreadsheet and analyzed using the statistical package Statistical Package for Social Sciences - SPSS, version 9.0. Calculating the gross and relative frequency provided the characterization of the studied population. To assess differences in proportion a binomial test was used on "main reason for seeking orthodontic treatment" according to sex, with a confidence interval of 95 %.

This study was approved by the Research Ethics Committee (REC) of the Southwest Bahia State University (UESB) under the protocol number 010/2008.

RESULTS

The studied sample consisted of 60 individuals, and there was predominance of women (74.1 %). Most (53.2 %) were between 18 and 21 years of age (Table 1).

According to the situation of orthodontic therapy, 38.3 % of the sample noticed that the treatment was successful. In this therapy, the type of orthodontic appliance used in most cases (96.4 %) was fixed metal brackets. The main reason behind the search for orthodontic treatment was reported by 66.7 % as the deviations in the occlusion (Table 2).

The main reasons that led to search for orthodontic treatment segregated by sex with respective percentages are shown in Table 3.

Regarding the duration of orthodontic treatment, 46.7 % of the participants considered it on schedule.

Table 1 - Characteristics of the sample.

Variables	n = 58	%
Gender		
Female	43	74.1
Male	15	25.9
Age		
18 to 21 years	33	53.2
21 to 25 years	27	46.8

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Table 2 - Patient expectations in relation to the orthodontic treatment.

Variables	n = 60	%
Orthodontic treatment situation		
Finished successfully	23	38.3
Finished unsuccessfully	6	10.0
In treatment, presenting improvement	20	33.3
In treatment, with no improvement	4	6.7
Not concluded	7	11.7
Main reason for searching orthodontic treatment		
Esthetics	29	48.3
Occlusal disturbances	40	66.7
TMJ pain	2	3.3
Treatment duration		
Quick	1	1.6
As expected	28	46.7
Long due to case complexity	16	26.7
Long due to lack of cooperation	15	25.0
Treatment results		
Very good. Esthetic, social and psychological improvement	26	43.3
Satisfactory, but did not change social and psychological life	24	40.0
Regular	4	6.7
Bad. Did not fulfill expectations	1	1.7
Bad. The problem relapsed	5	8.3
Type of orthodontic appliance*		
Metallic	54	96.4
Removable transparent	2	3.6
Interference of orthodontic treatment in social relations		
Partial, compromising smile and relations	2	3.3
Partial, without compromising social life	14	23.3
Did not interfere	44	73.3
Interference of orthodontic treatment in oral hygiene		
No difficulties in oral hygiene	18	30
Difficulties only in flossing	32	53.3
Difficulties in brushing and flossing	10	16.7
Main complaint about treatment		
Duration	19	31.7
Pain	35	58.3
Oral hygiene	13	21.7
Esthetics	1	1.7
Difficulty in chewing	14	23.3
Difficulty in using orthodontic auxiliaries	5	8.3
High financial cost	16	26.7

* n = 56.

Table 3 - Main reason that led patient to perform orthodontic treatment.

Variable	Female		Male		p-value*
	n	%	n	%	
Esthetics	26	90	3	10	< 0.001
Occlusal disturbances	15	75	5	25	0.41
TMJ pain	42	75	14	25	< 0.001

* Z test.

Table 4 - Patient expectations in relation to the orthodontist.

Variables	n = 60	%
Patients opinion in relation to the orthodontist		
Concerned with patient's health	46	76.7
Concerned with patient's health, but unprepared	3	5.0
Concerned with patient's health, but with no skills	5	8.3
Little concern with patient	6	10.0
Professional which should perform the orthodontic treatment		
General practitioner	2	3.4
Specialist	58	96.6

The results obtained with treatment were considered very positive by 43.3 %. As for the interference of the use of orthodontic appliance in social relations, 73.3 % of the sample rated that no kind of commitment to social life occurred. On the issue of oral hygiene, 53.3 % of the sample had difficulties to floss, and most (58.3 %) reported pain or discomfort as chief complaint resulting from treatment (Table 2).

As for the expectations of the volunteers in relation to the orthodontist, 76.7 % see the orthodontist as a professional concerned about the patient's health and 96.6 % felt that orthodontic therapy should be performed by a specialist in orthodontics (Table 4)

DISCUSSION

In the present study we found a prevalence of females, expressed in a 3:1 relation, relative to demand for orthodontic treatment. This suggests a greater tendency of women seeking orthodontic treatment, corroborating with the studies by other authors.[13,24,26,27] This proportion shows that women are more demanding about esthetics and appearance, and more uninhibited in expressing their dissatisfaction about themselves.[24]

Most participants (38.3 %), when asked about the situation of fixed orthodontic treatment, judged that it was successful. More important than the disfigurement due to malocclusion is the psychosocial impact and response caused by it, to determine the need for treatment and evaluation of the success of orthodontic therapy.[29] In an orthodontic approach it is fundamental to know the esthetic and functional complaints that lead the patient to seek treatment enabling a greater approach between the practitioners treatment and the patient's desires and concerns.

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Thus, greater collaboration is expected from the patient regarding orthodontic treatment and satisfaction with the results achieved.

The main factor that motivated the participants to seek orthodontic treatment was the occlusion deviation expressed by 66.7 % of subjects, this result corroborates those described in other studies, which emphasized as most frequent reason the presence of problems on biting and chewing.[10,18] The concern with dentofacial health is influenced by the individuals' sociocultural conditions.[25] The fact that the study sample is composed of individuals with high level of education suggests an influence of the expression of occlusal deviation as the main reason for treatment, since they can better recognize the impact of a malocclusion on their health.

Other studies are opposite to this reality when dentofacial esthetics is pointed as the primary cause in seeking orthodontic treatment without, however, excluding the functional reasons as prevalent in the decision for treatment.[7,8,1] Better social and work opportunities are crucial for esthetics to appear as the main factor in the demand for orthodontic intervention.[29] In this study, the esthetic factor was reported by 48.3 % of individuals as one of the most prevalent reasons for submission to orthodontic treatment.

Comparatively in the case of females in this study, the main reason for seeking orthodontic treatment was the esthetic factor ($p < 0.001$), emphasizing the idea that women have a greater concern with appearance and facial attractiveness and greater willingness to assume such fact. While for men the main reason cited was pain in Temporomandibular Joint (TMJ), within the established significance level ($p < 0.001$).

For most participants (46.7 %) there was a perception that treatment duration occurred within the predicted time. Orthodontic therapy is an intervention that requires, in most cases, a long period of time for its completion. In this sense, explaining to the patient this possibility, even before treatment is initiated, it is essential so that there is no mismatch between the time required to finish orthodontic treatment and patient's expectations. The long treatment period is also mainly associated to the non-attendance to orthodontic consultations for appliance activation.[2] Thus, it is important that the professional explains and motivates the patients regarding their responsibility for their own treatment. In this study, 25% of participants said that the treatment time was prolonged because of missed scheduled appointments.

When asked about the perception of treatment progress or outcome, most participants (43.3%) reported as very good, reporting esthetical, social, and psychological improvement. Based on this data, it was verified that the goals of orthodontic treatment were achieved, in the mentioned areas, contributing to improve the patient's facial esthetics and thereby raising their self-esteem and promoting their social relations. People from lower middle class considered orthodontic treatment more important than the upper middle class, because they believe that it represents an opportunity for better acceptance and social integration, enabling higher aspirations.[29]

For most individuals (96.4%), orthodontic treatment was performed with fixed appliances, which is expected, considering the studied age.

Most individuals in this study (73.3%) said that the fact of using fixed appliances did not interfere in their socio-affective relations. However, in a study that examined the factors that contribute to the acceptance of fixed appliances, an aversion in using it in public was found, but this reduces gradually with time and with the increased expectation of a good result.[4] As most volunteers had completed or were in the final stage of treatment, it is evident that the values found agree to what was previously mentioned, because most of them were satisfied with the results achieved with orthodontic treatment. The detailed explanation about the importance of completing treatment, emphasizing oral health and facial esthetics can facilitate the initial rejection to fixed appliances. The use of fixed appliances did not affect self-esteem during treatment and an improvement in self-image was observed, justifying the completion of treatment.[14,28]

Regarding oral hygiene during orthodontic treatment, most individuals (53.3%) reported difficulties in flossing. Failure of appropriate oral hygiene during orthodontic treatment may compromise treatment completion, since the risk of tissue damage, as demineralization of teeth and periodontal inflammation, may require premature discontinuation of therapy.[21] The components of the orthodontic appliance create additional retention sites for oral biofilm and at the same time hinder oral cavity hygiene.

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It is evident the difficulty in removing biofilm during orthodontic treatment mainly in the cervical region of teeth with orthodontic bands and interproximal regions with brackets.[19]

Thus, orthodontic treatment should aim both to correct patient's occlusion and to maintain the preexisting health of the teeth and supporting tissues. The individualization of preventive models is a decision to be made, considering the characteristics of each patient according to the risk of caries and periodontal disease, and even their level of cooperation.[9]

The main complaint of orthodontic treatment was pain, reported by 58.3% of participants. The pressures exerted by the fixed appliances on the periodontal ligament associated with increased friction of the brackets on the mucosa are the main sources of painful symptoms related to orthodontic therapy.[12] Other studies related the complaints arising from orthodontic therapy and showed that ulcers were the most annoying treatment factor, cited by 47% of respondents, followed by the discomfort caused by appliance activation, with 38% of complaints.[11] Orthodontics still has few resources for the adequate management of these complications.

The image of orthodontists from most of the participants (76.7%) was a professional committed to the restoration of their health. A good dentist values the interpersonal relationship, based on communication, seeking ways to preserve or restore oral health and showing kindness to patients, to their complaints and concerns.[22]

Most participants (96.6%) stated that orthodontic treatment should be performed by a specialist in orthodontics. Due to the technical complexity required to perform a treatment of this nature, plus the little knowledge in orthodontics offered in undergraduate courses of dentistry, it is evident the need for greater differentiation of the general dentist to practice the specialty. Patients judge the visits to the orthodontist much more pleasant than the general practitioner.[29] This may be a result of increased security and expertise transmitted to the patient during treatment, when performed by professionals who are experts in this area.

CONCLUSION

- Most participants in this study believed that their orthodontic treatment was successfully completed within the predicted time, resulting in esthetical, social, and psychological improvement.
- The main reason for seeking orthodontic therapy in this study is occlusion deviation, and in dichotomization for genders, esthetics appears as the main factor among women, and TMJ pain for men.
- For most participants fixed appliances do not interfere in their social-affective relations, but brings some degree of flossing difficulty regarding oral hygiene.
- The main complaint about the treatment reported by participants refers to pain and discomfort.
- Most individuals see the orthodontist as a professional concerned about the patient's health and think that orthodontic treatment should be performed by specialists.
- It is essential that the orthodontist establish an effective communication with patients to understand their desires in relation to orthodontic treatment, achieving a higher level of trust, cooperation and finally, the success of the instituted therapy.

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Evaluation of the influence of dental bleaching with 35% hydrogen peroxide in orthodontic bracket shear bond strength

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Objective: The purpose of this study was to evaluate, *in vitro*, the bond strength of brackets bonded to premolars previously subjected to bleaching with a 35% hydrogen peroxide.

Methods: Twenty one healthy premolars were selected and randomly divided into three groups (n = 7). Group I (G1) included teeth that were not submitted to bleaching. The enamel surfaces of Groups II (G2) and III (G3) were submitted to a bleaching process with 35% hydrogen peroxide (Whiteness HP Maxx). On Group II (G2), after bleaching, the teeth were stored for 24 hours in distilled water at 98.6 °F, and then, premolar metallic brackets were bonded using Transbond XT (3M) resin. Group III (G3) was submitted to the same procedure seven days after bleaching. After bonding, all teeth were stored in distilled water at 98.6 °F for 24 hours. All groups were submitted to a traction test using an EMIC DL2000 universal testing machine at a speed of 0.5 mm/min.

Results and Conclusion: The bracket resistance to debonding was compared between the groups by the Kruskal-Wallis nonparametric test ($p < 0.05$) and it was verified that the bleaching agent significantly reduced bracket adhesion when bonded 24 hours after bleaching. However, seven days after bleaching, there was no significant difference on the resistance to debonding among groups G1 (19,52 kgf) and G3 (18,44 kgf), meaning that it is necessary to wait longer after bleaching to bond brackets.

Keywords: Orthodontic brackets. Dental bleaching. Tensile strength.

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INTRODUCTION

Based on the current beauty standards, where beautiful is to have white and aligned teeth, the search for esthetic treatment is the desire of most patients that seek for a dental treatment.[9]

Dental bleaching is the most popular esthetic treatment with the purpose of modifying tooth color. Among the bleaching agents, hydrogen peroxide is the most used for treating intrinsic staining of healthy teeth, presenting or not endodontic treatment. Hydrogen peroxide presents several concentrations and periods of application.[10,20]

There are evidences in the literature that the utilization of bleaching agents can interfere on the bond strength of orthodontic brackets. Prietsch[14] concluded that dental bleaching with a 35% hydrogen peroxide reduces bond strength after 24 hours, suggesting that a period of seven days should be waited after bleaching. On the other hand, Matta[11] concluded that the bleaching agent with a 10% carbamide peroxide increases significantly the mechanical bond strength of orthodontic brackets, and that the elapsed time from the end of the bleaching treatment to the bonding of the orthodontic brackets did not interfere on the mechanical bond strength when it was performed after 24 hours or one week.

However, according to Bishara et al,[3] bleaching with a 10% carbamide peroxide does not interfere on bond strength of dental enamel. Thus, despite researches reporting the effect of bleaching agents to the dental enamel, it is noticed that there is no consensus about the real interference on bond strength of orthodontic brackets.

Therefore, due to the increasing demand of adult patients for orthodontic treatment, associated to increasing care for dental esthetic, it is relevant to perform an evaluation of the influence of bleaching with a 35% hydrogen peroxide on the bond strength of orthodontic brackets.

MATERIAL AND METHODS

To perform the present study, twenty one healthy human teeth (premolars) were stored in distilled water at 98.6 °F for 24 hours. The teeth were, then, randomly divided into three groups (n=7), according to waiting period post-bleaching (24 hours and 7 days) (Table 1).

Table 1 - Description of the sample according to the procedures performed in each group.

Groups (n = 7)	Procedures	
	Bleaching	Bonding
G1	No	24 hours
G2	Yes	24 hours
G3	Yes	7 days



Figure 1 - Mounting the teeth with acrylic resin to the PVC bases.

Using self curing acrylic resin, each tooth was mounted in two PVC bases with different diameters, so that the buccal surface of each tooth formed a 90 degree angle with the acrylic base (Fig 1). This was necessary to standardize the traction tests in the universal testing machine.

Group I (G1) or Control group included the teeth that were not submitted to bleaching. For this group bracket bonding was performed according to the same protocol adopted for the experimental groups. The enamel surfaces of Group II (G2) and III (G3) were submitted to bleaching with 35% hydrogen peroxide (Whiteness HP Maxx). The bleaching agent was applied for three times and activated by an halogen light, according to instructions from the manufacturer.

For Group II (G2), after bleaching, the teeth were stored for 24 hours in distilled water at 98.6 °F, then, the area to be bonded to the bracket in each tooth was bounded by a mask made from adhesive tape[11] (Fig 2A). After setting the mask, a prophylaxis with rubber cup

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and pumice paste and water was performed during 10 second for each tooth (Fig 2B), rinsing and drying (Fig 2C), with subsequent etching with 37% phosphoric acid for 15 seconds (Fig 2D), followed by rinsing for 10 seconds and drying for 10 seconds[11] (Fig 2E). Metallic brackets (Abzil) for premolars were bonded using the same amount of Transbond XT (3M) resin light cured for 40 seconds. All accessories were bonded at the same cervical distance, using a Boone gauge (Morelli) with a 4.0 mm distance (Figs 2F to 2M).

Group III (G3) was also submitted to the same procedures above described, but in this group the bonding was performed seven days after bleaching. After bracket bonding, all teeth were stored in distilled water at 98.6 °F for 24 hours. Then, all groups were submitted to the traction test using an EMIC DL2000 universal testing machine at a speed of 0.5 mm/min.[5] In this test the resistance values were obtained in kgf (kilogram-force) and registered by a printer attached to the machine (Fig 3A).

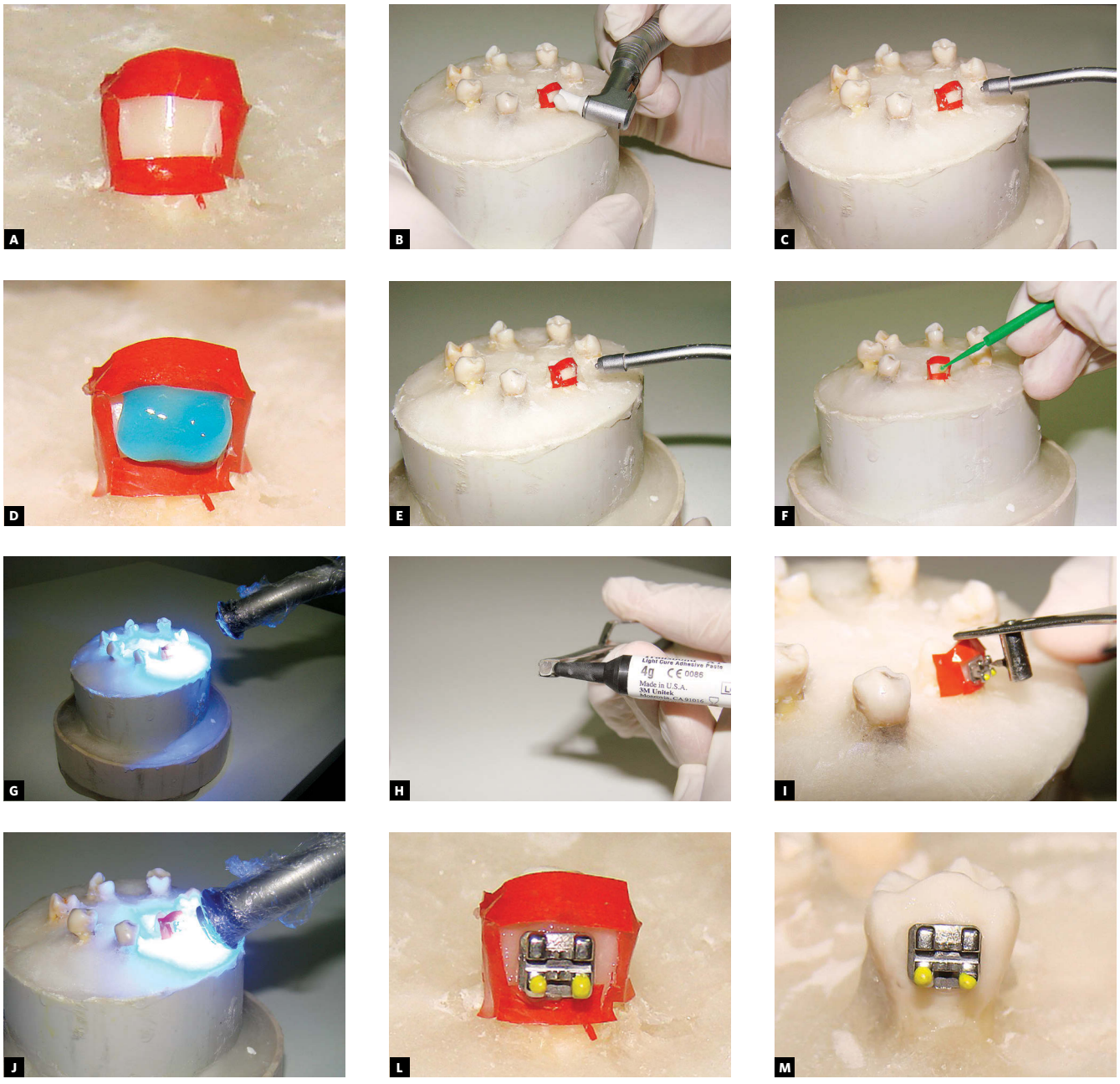


Figure 2 - **A**) Setting the mask. **B**) Prophylaxis (10s each tooth). **C**) Rinsing and drying. **D**) Acid conditioning (15s). **E**) Rinsing and drying (10s each tooth). **F**) Applying the primer. **G**) Photopolymerization of the primer. **H**) Applying the resin on the bracket base. **I**) Checking the distance of the accessory (4.0 mm). **J**) Photopolymerization. **L**) Bracket attached before removal of the mask. **M**) Bracket attached after removal of the mask.

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Then, a descriptive analysis of the mean and standard deviation for the tensile resistance (kgf) was performed for all groups.

The influence of 35% hydrogen peroxide bleaching agent on the bonding strength of orthodontic brackets was evaluated comparing the traction force (kgf) results necessary to debond the accessories.

The Kruskal-Wallis nonparametrical test, with significance level of 5% ($p < 0.05$), using the SPSS 13.0 was applied.

RESULTS

The results (Table 2 and Fig 4) showed that there was a statistically significant reduction on the bond strength when compared to the Control group (19.52 kgf) and to the group where bonding was performed 24 hours after bleaching (12.31 kgf). When the bracket debonding strength was confronted with the Control group and the group where bonding was performed seven days after bleaching (18.44 kgf), it was noticed that there was no statistically significant differences.



Figure 3 - Emic DL2000 universal testing machine.

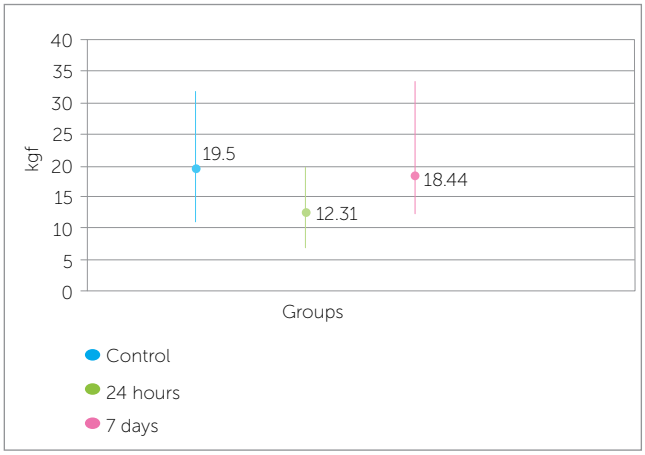


Figure 4 - Mean values and standard deviation of bond strength (kgf).

Table 2 - Bond strength values (kgf) obtained for each group according to tensile test.

Group	N	Minimum	Maximum	Mean	Standard Deviation
control	7	11.67	32.74	19.52[a]	6.537
24 hours	7	8.01	18.17	12.31[b]	3.240
7 days	7	11.42	35.78	18.44[a,b]	9.722

Kruskal Wallis nonparametrical test $p < 0.05$. Distinct letters (a/b) represent that there was statistical difference.
Control X 24 hours – $p = 0.025$*. Control X 07 days – $p=0.098$. 24 hours X 07 days – $p = 0.338$.

Table 3 - Evaluation of the influence of bleaching agents on the bonding strength of orthodontic brackets, according to existent studies.

Author	Type of tooth	Bleaching agent	Test	Resistance
Matta, Maia, Chevitarese[11]	Bovine	10% carbamide peroxide	Shear	Increase
Prietsch et al[14]	Bovine	35% hydrogen peroxide	Shear	Decrease
Uysal et al[21]	Humans	35% hydrogen peroxide	Shear	No alteration
Dishman et al[6]	Humans	25% hydrogen peroxide	-	Decrease
Quintella[16]	Humans	35% hydrogen peroxide	Shear	Decrease
Miles et al[12]	Humans	10% carbamide peroxide	Traction	Decrease
Homewood, Tyes, Woods[7]	Humans	Hydrogen peroxide	Shear	No alteration
Van der Vyver et al[22]	-	Hydrogen peroxide	-	Decrease
Bishara et al[2]	Humans	10% carbamide peroxide and 25% hydrogen peroxide	Traction	No alteration
Bello, Souza[1]	Humans	10% carbamide peroxide	Traction	Increase
Kraether, Souza[8]	Humans	10% carbamide peroxide	Traction	Increase

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DISCUSSION

According to the literature on the influence of bleaching agents on the bonding strength of orthodontic brackets, there is still some doubt if these substances interfere negatively on bonding strength or not, since in some works there is a reduction on the adhesion, in others there is an increase and yet in some others there is no alteration (Table 3). A careful observation of these studies allows to number a series of variables that can explain the great variation in the results, such as: Type of bleaching agent, bleaching technique, type of enamel (human or bovine) and type of debonding tests (traction or shear).

The values obtained from the present study indicate a decrease on the bond strength of orthodontic brackets immediately after bleaching. These results were confirmed by others works,[6,12,14,16,22] which also obtained a reduction on the bond strength depending on the waiting period post-bleaching. However, some authors[1,8,11] presented different results and obtained an increase on the bond strength. The results found by Homewood et al,[7] Uysal et al[21] and Bishara et al[2] showed no alteration on adhesion.

The reduction of bond strength can be explained by a significant decrease on the calcium/phosphorus relation on the enamel bleached with hydrogen peroxide, affecting adversely the dental hard tissues.[17] Another reason for this decrease on the adhesion can be the fast decomposition of the residual bleaching agent, releasing oxygen into the porosities on the tooth surface. This oxygen has the capacity to inhibit the polymerization of the resinous material used in the procedures of bracket bonding, compromising the conversion degree of monomer to polymer and consequently, the union of the material with the enamel structure.

Therefore, the results of the present study suggest a waiting period of about seven days after bleaching to bond any accessory on the enamel surface, in order to minimize possible adverse effects of bleaching to adhesion.

CONCLUSION

From the results obtained in this *in vitro* study, it can be concluded that the dental bleaching with a 35% hydrogen peroxide, reduced significantly the bond strength of orthodontic brackets when bonding was performed 24 hours post-bleaching. However, after seven days from bleaching, differences were not noticed on bond strength, being recommended a longer waiting period when bonding of any accessory on the enamel surface submitted to bleaching agents is necessary.

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Maxillary incisor retraction: Evaluation of different mechanisms



Antônio Carlos de Oliveira Ruellas[1], Matheus Melo Pithon[2], Rogério Lacerda dos Santos[3]

Objective: To mechanically evaluate different systems used for incisors retraction.

Methods: Three different methods for incisors retraction using 0.019 x 0.025-in stainless steel wire were evaluated. The samples were divided into three groups: Group A (retraction arch with 7-mm high vertical hooks); Group G3 (elastic chain attached to the mini-implant and to the 3-mm stainless steel hook soldered to the retraction arch); Group G6 (elastic chain attached to the mini-implant and to the 6-mm stainless steel hook soldered to the retraction arch). A dental mannequin was used for evaluation in order to simulate the desired movements when the device was exposed to a heat source. The analysis of variance (ANOVA) and the Tukey test were used ($p < 0.05$).

Results: The results demonstrated that Groups G3 and G6 exhibited less extrusion and less incisor inclination during the retraction phase ($p < 0.05$). With regard to incisor extrusion, statistically significant differences were observed between Groups A and G3, and between Groups A and G6 ($p < 0.05$). Regarding incisor inclination, statistically significant differences were observed between the three systems evaluated ($p < 0.05$).

Conclusions: Arches with 6-mm vertical hooks allow the force to be applied on the center of resistance of the incisors, thus improving mechanical control when compared with the other two systems.

Keywords: Fixed orthodontics. Malocclusion. Maxillary incisors.

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INTRODUCTION

For many years, orthodontists have sought an efficient force system that is capable of working rapidly, precisely and efficiently in order to shorten the treatment time. On the other hand, it must be known how to control and manipulate this system.

Good control in the retraction of anterior teeth during space closure is essential for successful orthodontic treatment.[12,13] The incorporation of hooks in the retraction arch allows one to adjust the height of the line of action of the force by means of different lengths of soldered hooks.[2,8]

With the advent of mini-implants, these began to be used as orthodontic anchorage in the retraction of anterior teeth,[1] in particular, cases that did not allow for anchorage loss have perhaps been the most mentioned indication in the literature,[4-7,9,11] such as in severe bimaxillary protrusions or Angle's Class II malocclusions to be treated with premolar extractions.

With the purpose of better elucidating the system for maxillary incisor retraction, the aim of this study was to mechanically evaluate different systems used for the retraction of these teeth with and without the use of mini-implants.

MATERIAL AND METHODS

In order to conduct this experiment, a methodology was developed, in which a Dental mannequin (Prodens F2/PD002, Carapiá Ind. Com. Prod. Odont. LTDA, São Gonçalo, RJ, Brazil), mounted in normal occlusion was used, for the purpose of training undergraduates in Dentistry. Before the experiment was conducted the mannequin was prepared by removing the alveolus to enable the teeth to be moved, thus creating a channel with 2.4 cm in height and 1.2 cm wide, which in turn was filled with an utility wax compound (Polidental Ind. Com. LTDA, São Paulo, São Paulo, Brazil) in pink and transparent colors with heat sensitive characteristics. To open the channel, a No. 15 scalpel blade (Solidor, Barueri, São Paulo, Brazil) was used mounted in a scalpel handle and a finishing bur for acrylic resin (H79E 104 040, Komet, Gebr. Brasseler, Lemgo, Germany).

This method was based on Typodont operation routinely used in teaching dentistry students, with the difference that the wax used in the present study was sensitive to the heat produced by an electrical resistance inside a glass chamber, thereby maintaining an environment at 48 °C, and not needing to be submerged in hot water as occurs with regular Typodonts.

Once the mannequin was adapted, the teeth were mounted in a Class I malocclusion, with bimaxillary protrusion. To standardize the malocclusion with the canine already retracted, all teeth (first and second molar, second premolar and canine) were disposed in the same position and referenced on the mannequin base, in addition to teeth intercuspation with their antagonists, since the mandibular arch was identical in all cases.

This malocclusion was chosen due to the fact that the therapy commonly used in these cases is extraction of the first premolars followed by canine and incisor retraction.

After the mannequin was mounted, orthodontic brackets (Dental Morelli LTDA, Sorocaba, São Paulo, Brazil) were bonded according to the edgewise technique, slot 0.022 x 0.030-in, which served as support for application of orthodontic mechanics. For bracket placement, individual occlusal positioners were fabricated with Orto Clas acrylic resin (Clássico, São Paulo, SP, Brazil) and 0.021 x 0.025-in steel wire (American Orthodontics, Sheboygan, Wisconsin, USA) as a guide. A 5 mm height (incisal or occlusal surface to the center of the buccal surface) was used for the incisors, canines and premolars, and 4.5 mm for molars.

After the orthodontic appliance was placed, the mannequin was fixed to a rigid rod. The hole for the mannequin's fixation, located in its posterosuperior part, was fixed to a steel rod 1.0 cm in diameter and 1.50 meters high, fixed perpendicularly to the ground.

To standardize the mannequin's position parallel to the ground, the upper base and the occlusal plane were projected in the same position and height on the fixation rod. A steel ruler 30 cm long (Flex-30, Trident Indústria de Precisão LTDA, Itapuí, São Paulo, Brazil) was placed perpendicular to the occlusal plane, for the purpose of measuring incisor extrusion that occurred during retraction.

An orthodontic mini-implant (POT 1618, SIN - Sistema de Implantes, Mooca, São Paulo, Brazil), was inserted 6 mm from the papilla between the roots of the maxillary first molar and second premolar, in the region of the mucogingival line which, according to Park,[10] is the site of choice for the insertion of mini-implants destined for the retraction of anterior

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teeth. Three different methods for incisor retraction were evaluated (Fig 1), using an orthodontic retraction arch made with 0.019 x 0.025-in stainless steel wire (American Orthodontics, Sheboygan, Wisconsin, USA), thus the groups were divided as follows:

» Group A: Retraction performed with a retraction arch with 7 mm high vertical loops;

» Group G3: Retraction performed with elastic chain attached to a 3 mm high stainless steel hook, soldered to the retraction arch, and to a mini-implant;

» Group G6: Retraction performed with elastic chain attached to a 6 mm high stainless steel hook, soldered to the retraction arch, and to a mini-implant.

The hooks were soldered with silver solder (Dental Morelli LTDA, Sorocaba, São Paulo, Brazil). After soldering, maintenance of the physical-mechanical characteristics of the retraction arches was verified. The angular measurement were obtained by the intersection of the line projected parallel to the mannequin's upper base and long axis of the maxillary right central incisor, before and after incisor retraction (Figs 2, 3 and 5). The linear measurements were obtained starting from a point between the central incisors on the retraction arch, parallel to the palatine raphe up to a line projected perpendicularly in the distal direction of the maxillary second molars.

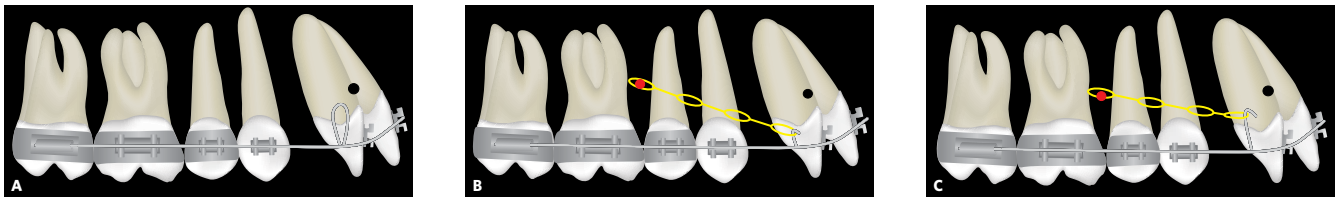


Figure 1 - Photos of the different retraction systems: **A**) Vertical loop retraction arch; **B**) Mini-implant and 3-mm soldered hook; **C**) Mini-implant and 6-mm soldered hook.

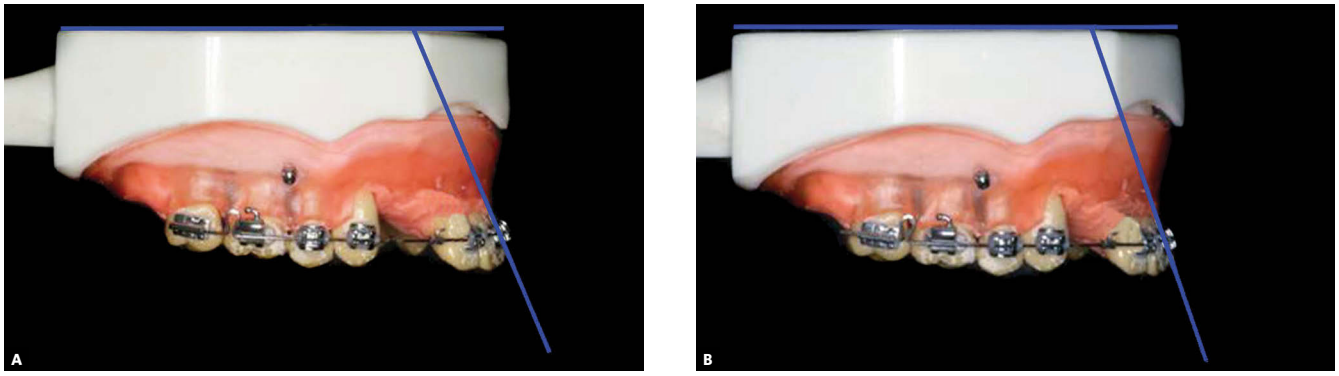


Figure 2 - A) Incisor position before retraction with chain elastics and a 3-mm hook and mini-implant; **B**) retracted incisors.

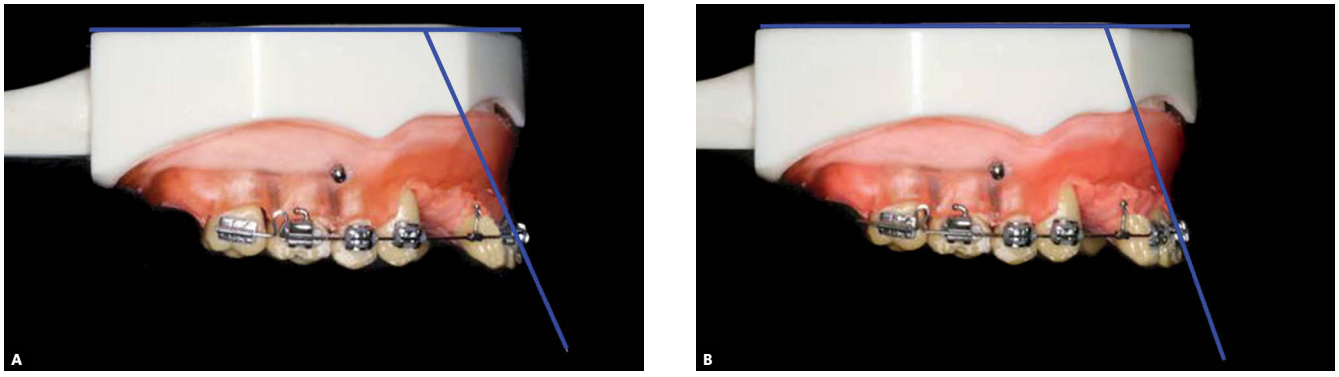


Figure 3 - A) Incisor position before retraction with chain elastics and a 6-mm hook and mini-implant; **B**) retracted incisors.

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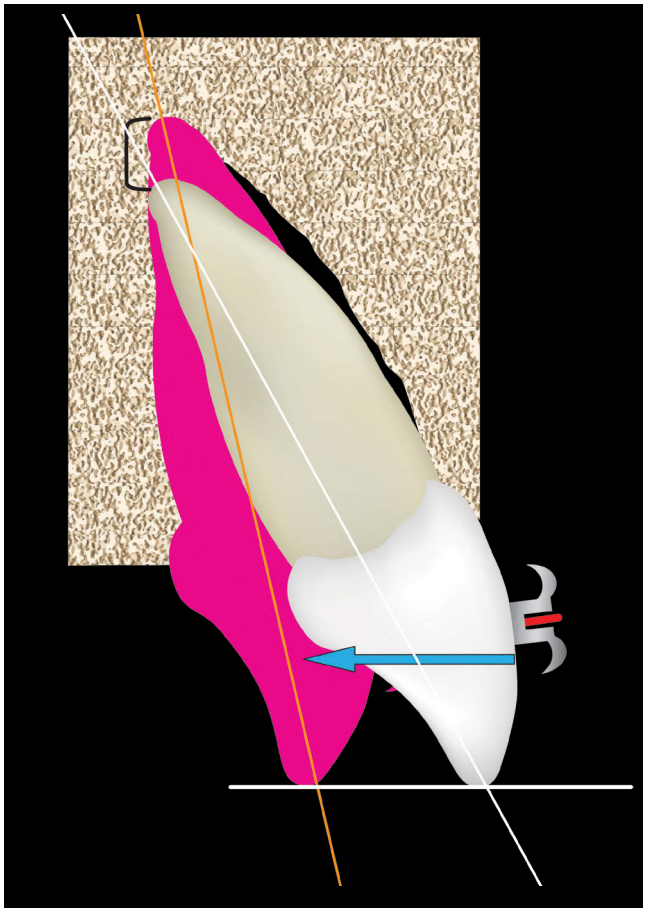


Figure 4 - Illustration of the smallest incisor extrusion and palatal inclination during retraction in the soldered hook groups.

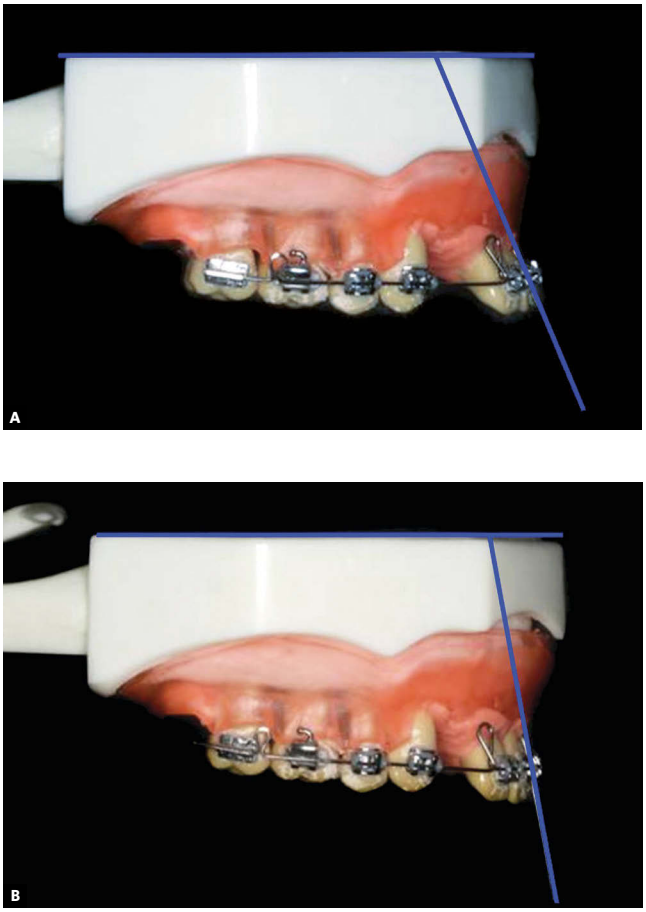


Figure 5 - A) Incisor position before retraction with vertical loops; B) Retracted incisors.

Group A was activated by means of a tieback with metal ligature (mechanics without sliding). Groups G3 and G6 were activated with the use of elastic chains (854-299 Silver, American Orthodontics, Sheboygan, Wisconsin, USA) (sliding mechanics). All the groups were activated with the aid of a dynamometer (Dentaurum 040-711, Ispringen, Germany) with the purpose of activating and standardizing the force measurement (130 gf) necessary for promoting retraction of the teeth, on an average of 1 mm per minute. The incisors were retracted to an extension of 8 mm, with 15 repetitions being performed in each system, thus enabling the groups to be statistically evaluated. With each new test, the malocclusion was remounted by following all the previously mentioned steps and the position and angulation of the teeth in relation to the upper base, as well as of the teeth in relation to the bottom base of the mannequin were checked.

After data collection, statistical analysis was performed with the use of the SPSS 13.0 program (SPSS Inc.,Chicago, Illinois). The values of the amount of extrusion and inclination of the incisors, before and after retraction, obtained in millimeters and angles were submitted to the analysis of variance (ANOVA) to determine whether there were statistical differences among the groups, and afterwards to the Tukey test ($p < 0.05$).

RESULTS

The results demonstrated that the system composed of mini-implant / Elastic / hook (Groups G3 and G6) favored less extrusion of the incisors (Table 1) and less palatal inclination (Table 2) of the incisors in the retraction phase ($p < 0.05$) (Figs 2, 3 and 4). The retraction system with vertical loops activated with tieback ligatures (Group A) favored greater inclination and extrusion of the incisors (Figs 5 and 6) compared with groups G3 and G6.

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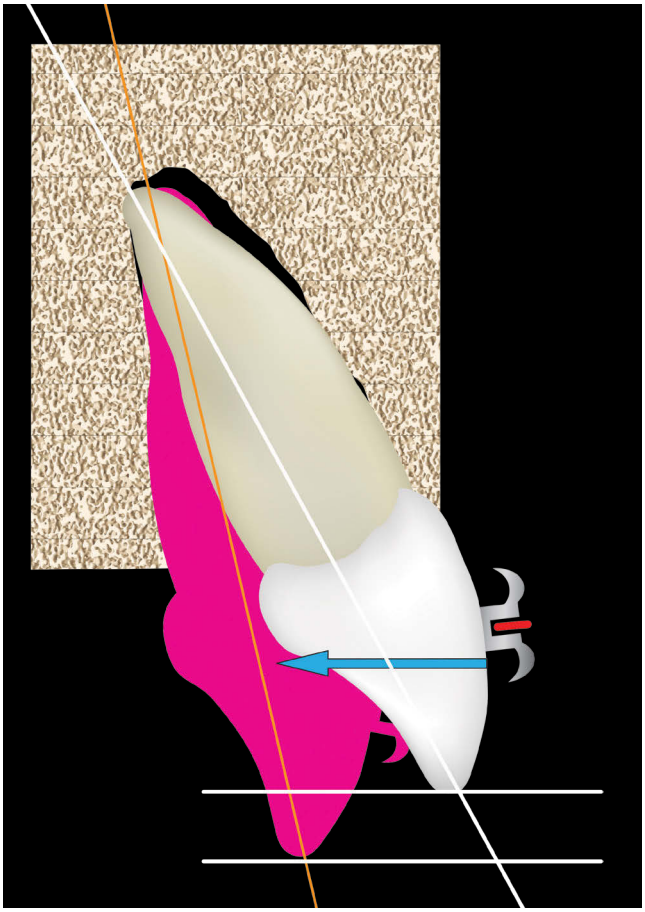


Figure 6 - Illustration of the greatest incisor extrusion and palatal inclination during retraction in the vertical loop group.

Table 1 - Values of the amount of extrusion among the evaluated groups.

Groups	n	Mean (mm)	S.D.	Statistical analysis *
A	15	2,6	0,4	A
G3	15	0,3	0,1	B
G6	15	0,4	0,2	B

* Equal letters indicate absence of statistical differences.

Table 2 - Values of inclination acquired by the incisors after retraction.

Groups	n	Mean (mm)	S.D.	Statistical analysis *
A	15	-12	-5	A
G3	15	-7	-3	B
G6	15	-2	-2	C

* Equal letters indicate absence of statistical differences.

As regards extrusion of the incisors, there was statistically significant difference between Groups A and G3, and A and G6 ($p < 0.05$), however there was no statistically significant difference between Groups G3 and G6 ($p > 0.05$) (Table 1).

Regarding inclination, there was statistically significant difference between the three systems evaluated ($p < 0.05$) (Table 2), however, Group A presented notably greater inclination of the incisors when compared with the other groups (Table 2).

DISCUSSION

Precise knowledge of the mechanical implications of orthodontic appliances is a decisive factor in the success or failure of treated cases. The retraction stage of anterior teeth is one of the most critical stages of orthodontic treatment, and requires precise mechanical knowledge, thus avoiding undesirable movements and loss of control during treatment.

Based on this premise, the aim of the present study was to evaluate the mechanical component of three methods of incisor retraction, with the purpose of providing orthodontists with information that they could apply in their daily clinical practice.

With regard to the inclination acquired by the incisors during retraction, Group A showed the greatest amount, followed by Groups G3 and G6, with statistical difference between the groups; that is, the longer the distance from the force to the center of resistance, greater was the inclination acquired by the incisors (Fig 7). In Group A, the moment generated by the torque (lingual root torque) was not sufficient to balance the torque generated by the force (lingual crown torque). This could solved by incorporating active torque on the maxillary incisors (Fig 8). In Groups G3 and G6, in addition to the moment generated by the torque, there is a moment generated by the one-couple system (Fig 9A), due to torsion of the wire in the anterior region as a result of the force applied (Fig 9B) to the hook (the longer the hook, greater the effect). Thus, in Group G6 most movements were practically translation.

Incisor retraction with uprighting results in greater exposure of the incisors in relation to the lip if no mechanical resource is used for vertical control (incisor intrusion).

When the quantity of extrusion acquired by the incisors during retraction was compared, Group A presented greater extrusion than the other groups. This fact may be justified by the vertical position of the line of action of the force, being more distant from the center

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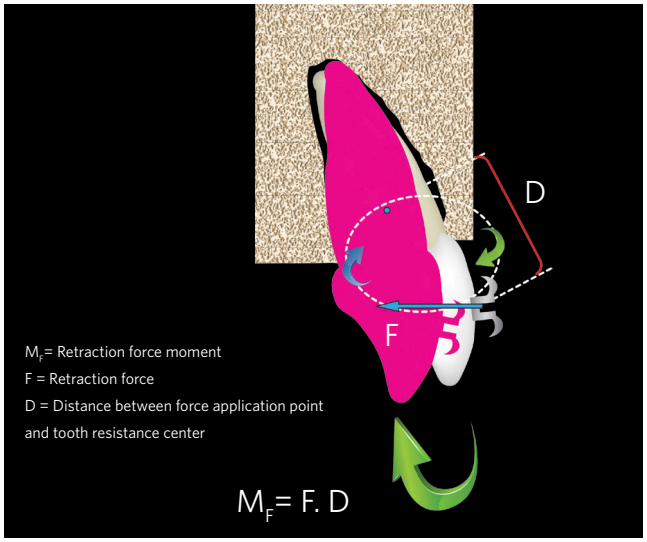


Figure 7 - Illustration of the moment caused by the retraction force.

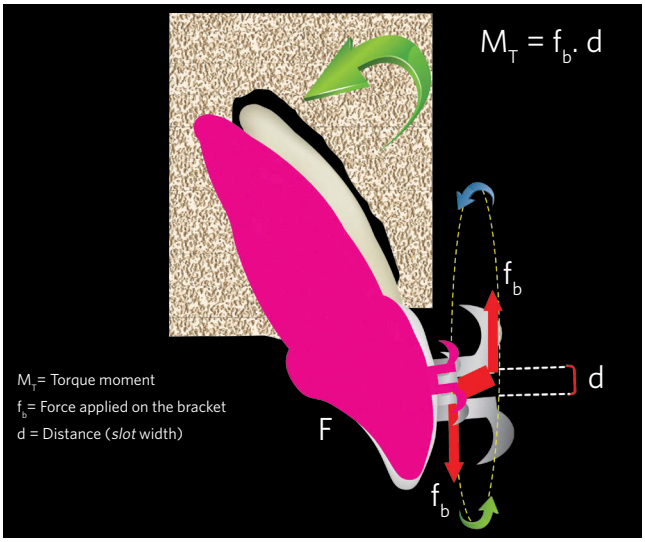
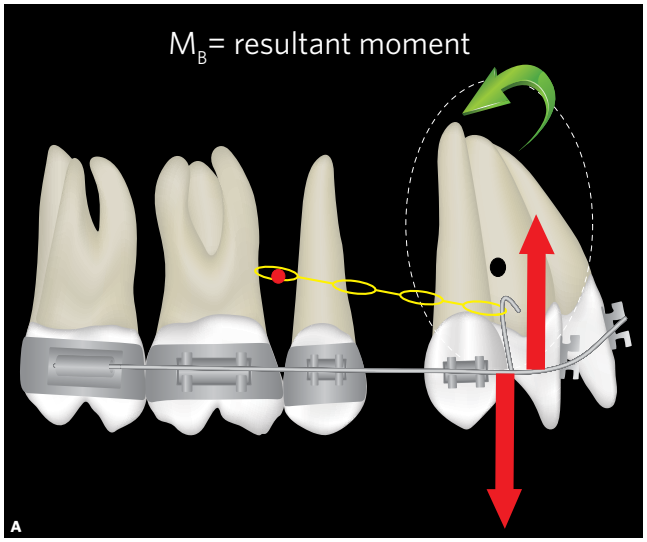


Figure 8 - Moment caused by the torque inserted to the archwire.



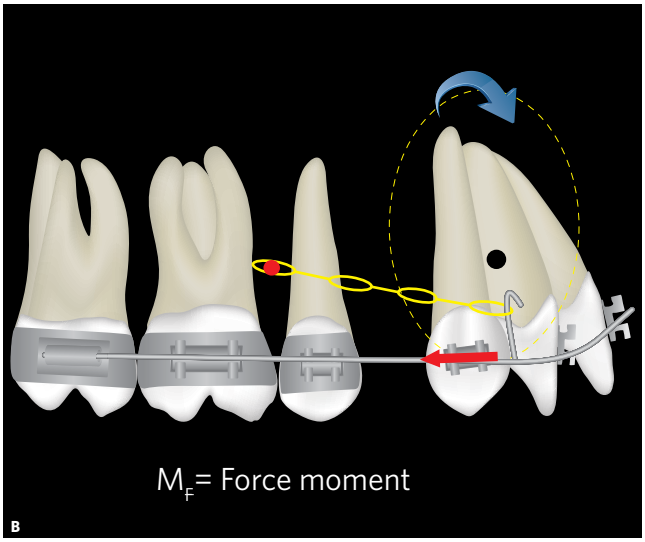


Figure 9 - **A**) Illustration of the moment generated by both forces due to the archwire torsion in the 6-mm hook group; **B**) Illustration of the moment generated by the retraction force applied to the 6-mm hook group.

of resistance, and consequently increasing incisor inclination (verticalization). It might compromise esthetics with greater exposure of the incisors and a gummy smile, in addition to overbite becoming larger.

Groups G6 and G3 showed no statistical difference between them as regards extrusion. The discrete reduction in extrusion caused in Group G6 in comparison with Group G3 was due to the larger size of the hook, which obtained greater proximity of the line of action of the force with the center of resistance of the anterior segment, which allowed better control of palatal inclination of the incisors. Thus, the closer the force's line of action to the center of resistance, greater the extrusion control.

The findings of this study are in agreement with analyses proposed by Burstone,[2] Burstone and Pryputniewicz.[3] They showed that the center of rotation moved apically from the center of the root as the height of force application was raised in the direction of the apex. When the height of force application was above the center of resistance in the incisal direction, the center of rotation was displaced in the incisal direction, thus tooth inclination and extrusion would depend on the direction of force application.

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It may be observed that the different systems presented distinct lines of action of force, and that their relationship with the center of resistance of the incisors showed different intensities of angular and linear movements. As the height of force application was displaced in the apical direction, as in Group G6, the center of rotation was also displaced in the same direction.

Clinically, it becomes important to approximate the line of action of force to the center of resistance of the tooth to the maximum extent whenever possible. Among the resources for this purpose, one could bond accessories in a more cervical direction, using longer hooks soldered to the arch or to the distal wing of the bracket, or the use of sliding jigs.

The group with the 6 mm hook presented better results probably due to the fact that the system produced more bodily movement (translation) than palatal inclination, however the greater difficulty in moving the root in the distal direction simultaneously to the crown, probably requires a longer retraction time, or greater force application.

CONCLUSIONS

By conducting this study, it could be concluded that:

» Arches with vertical 6 mm high soldered hooks allowed approximation of the line of action of force to the center of resistance of the incisors, providing better mechanical control.

» Association of palatal torque on the retraction arches of anterior teeth is suggested to increase vertical control and diminish the palatal inclination of the incisors during the movement of retraction.

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Changes on facial profile in the mixed dentition, from natural growth and induced by Balters' bionator appliance

Denise Rocha Goes Landázuri[1], Dirceu Barnabé Raveli[2], Ary dos Santos-Pinto[2], Luana Paz Sampaio Dib[3], Savana Maia[4]

Objective: The purpose of this study was to evaluate the facial profile changes induced by Balters' bionator appliance in Class II division 1 patients, at mixed dentition stage.

Methods: The sample consisted of 28 pre-pubertal individuals at stages 1 and 2 of skeletal maturation (CVM), which were divided in two groups. The experimental group consisted of 14 individuals (7 boys and 7 girls, initial mean age of 8y12m) which were treated with Balters' bionator appliance for 14.7 months. The effects of treatment were compared to a control group of 14 subjects (7 boys and 7 girls, initial mean age of 8y5m) with Class II malocclusion, division 1, not orthodontically treated, which were followed up for 15.4 months. The statistical analysis was performed using Student's t test, at a significance level of 5%.

Results: The results showed that the Balters' bionator appliance promoted a significant increase on the mentolabial angle, in addition to demonstrating a tendency to reduce the facial skeletal convexity, to restrict the maxillary growth and to increase the nasolabial angle and the lower anterior facial height.

Conclusion: It can be concluded that the Balters' bionator appliance improved the facial profile of children treated at mixed dentition stage.

Keywords: Activator appliances. Angle Class II malocclusion. Cephalometry.

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INTRODUCTION

Achieving an esthetically pleasing face is one of the main goals of orthodontic treatment, and since the beginning of orthodontics, great researchers such as Kingsley,[16] Case[10] and Angle[3] emphasized the importance of the interrelation between esthetics and this specialty. However, to achieve this goal, it is necessary that the orthodontist deeply understand not only the biomechanical aspects related to tooth movement, but also the continuous changes that occur during facial growth and development of natural individuals.[27]

The introduction of cephalostat in dentistry[9] allowed the standardization of lateral teleradiography and allowed the accomplishment of more accurate dentoskeletal and facial profile assessments. Thus, combining the results of cephalometric analysis associated to clinical and subjective examination by each professional will enable the achievement of an ideal occlusion with functional stability and facial esthetic.[1,20,26]

Despite the various cephalometric analysis proposed in literature, initially, little emphasis was given to the analysis of the soft tissue profile, due to the inadequate concept that changes on soft tissue would accurately follow the repositioning of subjacent skeletal and dental tissues.[19] Currently, it is known that due to the large variability inherent to soft tissues — such as thickness and tonicity, especially of the lips —, they can mitigate or protrude the contours of the subjacent anatomical structures.

The concept of the ideal profile has been discussed in literature[8,14,23,25] and despite of accepting variations due to differences among races, countries, culture and time, the straight or slightly convex profile is still synonymous of beauty. As the aspect of the facial profile in patients with Class II malocclusion, division 1, with mandibular retrusion is quite convex, one of the main goals of this treatment is to improve facial aesthetics, by reducing the profile convexity.[22]

Class II malocclusions are characterized by an imbalance between bone bases in the anteroposterior direction, which can result in maxillary basal protrusion, maxillary dentoalveolar protrusion, mandibular deficiency, mandibular dentoalveolar retrusion or a combination of these factors.[12,15] This maxillomandibular discrepancy is present in a significant percentage of the population,[18,30] and is considered the most frequent in orthodontics practice. In Brazil, according to an epidemiological study conducted by Silva Filho et al,[29] with 2,016 children of 07-11 years-old, both genders, Class II malocclusion showed a prevalence of 42 %, being 27 % of dental origin and 15 % considered as skeletal Class II. Thus, it explains the large number of patients with this clinical feature who seek orthodontic clinics to address the esthetic and functional problems triggered by this malocclusion.

The treatment of Class II malocclusion, division 1, with mandibular deficiency in growing patients aims the mandibular advancement, to achieve better relations between bone bases and improve the convex facial profile. Among the functional orthodontic devices intended for this purpose, Balters' bionator is highlighted. It was developed by Wilhelm Balters in the 50's.[13] He believed that improper posture of the tongue, which was placed in a retruded manner, would be responsible for a disturbance in cervical region, change in respiratory function, atypical deglutition and consequent impairment of mandibular growth.[5] Therefore, Balters designed a device to promote an anterior mandibular positioning, enabling the tongue to occupy a normal intraoral position and, also, lip competence.[19]

The few data reported in the literature about possible changes on facial profile of children with Class II malocclusion, division 1, due to mandibular retrusion treated with Balters' bionator, led us to evaluate the effect of treatment with this device.

PURPOSE

The aim of this study was to provide data to assess changes in the facial profile resulting from natural growth and induced by the use of Balters' bionator device in children, before the growth peak of the pre-pubertal period, more specifically in stages 1 and 2 of skeletal maturation, observed through the analysis of cervical vertebrae.

MATERIAL AND METHODS

Material

The sample used in this study was obtained from two distinct populations: Brazilian and Canadian. Individuals were divided into two groups: the experimental group treated with Balters' bionator and a control group that received no orthodontic treatment.

Experimental group

The experimental group consisted of 14 patients treated with Balters' bionator, 7 males and 7 females. The inclusion criteria used were: Class II division 1 facial pattern, associated with mandibular retrusion; Class II,

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division 1, dental relation; permanent upper and lower central and lateral incisors erupted or erupting, no mandibular crowding, 5-7 mm overjet, mixed dentition and absence of cross-sectional problems.

All patients were treated with Balters' bionator, which was based on the original design proposed by Balters[5] and adapted by Ascher,[2] having the acrylic extension of the lower arch deeper than the original, and covering the incisal and cusps of the incisors and canines, respectively (Fig 1), so that the effect of inclination of the lower incisors was decreased.

The mandibular advancement was carried out in a unique way to obtain a cusp to cusp relation with incisors and, for patients whose overjet was more accentuated, the reference was the canine relation in Class I. For these cases, the treatment was carried out in two phases: The first phase with canine relation in Class I, and the second phase with the incisors in a cusp to cusp relation.

Control group

The control group was selected from the documentation files of the Burlington Growth Centre, located in the Department of Orthodontics, Faculty of Dentistry, University of Toronto, Canada. This sample consisted of 14 individuals, 7 males and 7 females, randomly selected from a group of 20 individuals. Selection criteria for this group were: Class II division 1 facial pattern, associated with mandibular retrusion; Class II division 1 dental relation; upper and lower central incisors erupted, mixed dentition and no previous orthodontic treatment.

These individuals were randomly paired with patients of the same gender from the experimental group, and selected the observation times that corresponded to the age, in complete years, of the respective pair.

The descriptive data about age and time of treatment for the experimental and control groups are shown in Tables 1 and 2, respectively.



Figure 1 - Side and front view of Balters' bionator.

Determination of skeletal maturation

The determination of skeletal age was verified through lateral teleradiographies, using the indicators of skeletal maturation of cervical vertebrae. The bone age determination was performed by the same operator and in a blind study, i.e., without identification of the patient evaluated, which reduces the subjectivity of this evaluation. Thus, the selected individuals were located in the maturation stages 1 and 2, i.e., before the growth peak of pre-pubertal period, according to Baccetti, Franchi, McNamara;[4] O'Reilly and Yanniello.[21]

METHODS

For each individual, it were obtained two lateral cephalograms, called T_1 (beginning of treatment) and T_2 (end of treatment), for the experimental group; and T_1 (beginning of the observation period) and T_2 (end of the observation period) for the control group.

Although the radiographs had been obtained by different X-ray equipments, it was not performed a correction for image magnification. The difference of

Table 1 - Descriptive data of patients' ages in experimental and control groups, according to gender and treatment stage.

	Experimental		Control	
	Mean	SD	Mean	SD
Female				
Baseline	8y 9m	6m	8y 3m	6m
End	10y 2m	4m	9y 9m	6m
Male				
Baseline	9y 2m	5m	8y 7m	6m
End	10y 3m	5m	9y 9m	6m
Both				
Baseline	8y 12m	6m	8y 5m	6m
End	10y 3m	5m	9y 9m	6m

Table 2 - Descriptive data of treatment period, in months, of the patients in experimental and control groups, according to gender.

	Experimental		Control	
	Mean	SD	Mean	SD
Female	16.7	4.6	17.1	6.4
Male	12.4	1.7	13.7	4.5
Both	14.6	4.0	15.4	5.6

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magnification percentage between samples would be 0.16 %, which would not affect the comparison of the variables displayed in radiographs obtained by different X-ray devices. This difference in image magnification corresponds to a difference in magnification between X-rays of 0.0016 cm (0.016 mm).

All radiographs were traced by hand by the same operator, the cephalometric points were digitized on a Numonics AccuGrid tablet, and evaluated through Dentofacial Planner Plus 2.01 computer software for obtaining cephalometric measurements.

Obtaining cephalometric measurements

The cephalometric measures used in this study are shown in Table 3 and Figure 2.

Statistical analysis

To evaluate the data, the following statistical tests were performed:

» Student's t-test for the equality of means of two independent populations: To examine the hypothesis that the mean of each measure in the control group did not differ from the mean of the experimental group at baseline (Table 4).

» Student's t-test for the equality of means of two populations with independent samples: To examine the hypothesis that the changes observed in a cephalometric measure between times 1 and 2 do not differ, in terms of means, in the control group and the experimental group (Table 5).

Table 3 - Cephalometric measures evaluated.

Cephalometric measures	Definition
1) Convex	Supplement of the angle that measures the convexity of the bone profile
2) LAFH	Linear measure that represents the height of the lower anterior facial third
3) SNA	Represents the anteroposterior position of the maxilla in relation to the anterior cranial base
4) SNB	Represents the anteroposterior position of the mandible in relation to the anterior cranial base
5) U1PP	Angle formed by the long axis of the upper incisor and the palatal plane
6) L1MP	Angle formed by the long axis of the lower incisor and the mandibular plane
7) U1L1	Angle formed by the long axis of the upper incisor and the long axis of the lower incisor
8) NL	Angle formed by the columella line and the upper lip
9) ML	Supplement of the angle formed by the line of the lower lip and the chin
10) UL_E	Linear measure between the most prominent point of the upper lip and the line E
11) LL_E	Linear measure between the most prominent point of the lower lip and the line E

RESULTS

To compare the changes that have occurred in the measurements, with and without treatment, it was necessary to eliminate the effect of the difference in time between the measurements performed in the experimental and control groups. For this reason, the changes in the measures were annualized (Table 5). The representation of the skeletal, dental and soft tissue changes is presented in Figure 3.

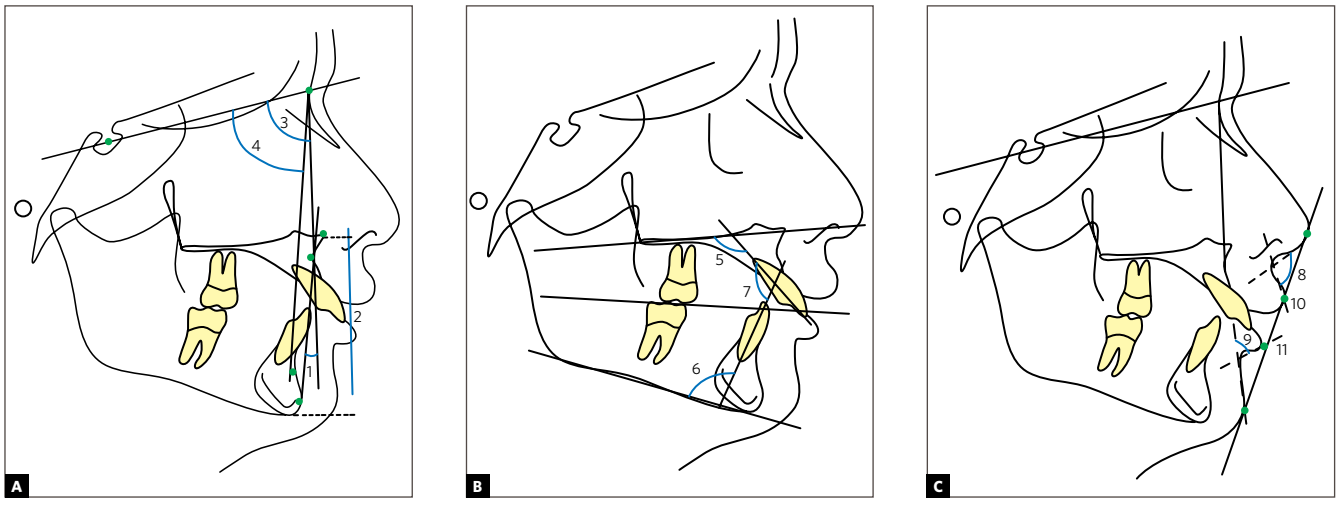


Figure 2 - Skeletal (**A**), dental (**B**) and soft tissue (**C**) cephalometric measures.

Table 4 - Means and standard deviations of measures at baseline for each group, Levene's test for comparison of variances and Student's t-test to compare the means of the two groups.

Measures	Experimental group		Control group		Levene's test		Student's t-test		
	Mean	SD	Mean	SD	F	p	t	df	p
Convex	8.8	4.91	8.0	4.45	0.02	0.884	0.47	26	0.645
LAFH	61.4	3.34	59.8	3.53	0.07	0.793	1.24	26	0.224
U1PP	113.9	9.02	112.5	5.49	2.68	0.114	0.49	26	0.630
L1MP	97.5	5.51	98.0	6.25	0.46	0.505	-0.21	26	0.834
NL	108.9	10.68	105.4	9.90	0.06	0.804	0.90	26	0.376
ML	**5.5**	1.27	**4.2**	1.10	1.00	0.327	**3.00**	**26**	**0.006**
UL_E	**0.5**	2.38	**-1.9**	1.64	1.11	0.304	**2.98**	**24**	**0.006**
LL_E	0.2	2.37	-1.5	2.15	0.78	0.386	1.90	26	0.069
U1L1	120.9	11.70	122.3	8.31	0.57	0.456	-0.36	26	0.719
SNA	82.0	5.07	79.6	3.69	1.30	0.265	1.47	26	0.155
SNB	77.3	3.95	75.0	2.38	2.65	0.115	1.81	26	0.082

Table 5 - Means and standard deviations of annualized changes of measures for each group, Levene's test results for equality of variances and Student's t-test for equality of mean changes.

Measure-ment	Experimental group		Control group		Levene's test		Student's t-test		
	Mean	SD	Mean	SD	F	p	t	df	P
Convex	-0.9	2.91	0.0	2.36	1.81	0.190	-0.86	26	0.396
LAFH	1.4	1.20	0.7	1.20	0.05	0.828	1.48	26	0.151
U1PP	-4.5	7.59	-0.6	2.95	2.88	0.102	-1.80	26	0.084
L1MP	1.5	4.13	0.9	4.55	0.00	0.994	0.34	26	0.735
NL	4.3	8.23	1.6	6.44	2.10	0.159	0.97	26	0.340
ML	**-0.8**	0.94	**0.1**	0.58	3.49	0.073	**-3.10**	**26**	**0.005**
UL_E	-0.7	1.21	0.0	1.24	0.03	0.866	-1.50	26	0.145
LL_E	0.3	1.26	0.5	1.03	0.04	0.845	-0.44	26	0.662
U1L1	3.0	6.97	0.2	4.96	2.48	0.127	1.21	26	0.236
SNA	-0.6	1.55	0.4	1.91	0.04	0.843	-1.45	26	0.160
SNB	0.2	1.16	0.4	1.32	0.20	0.658	-0.41	26	0.684

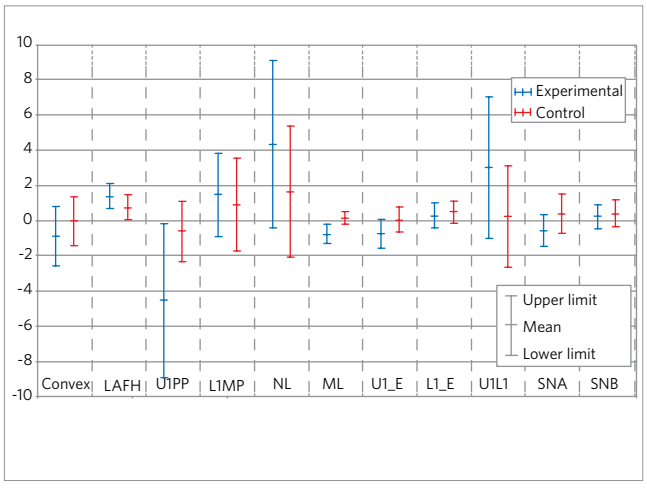


Figure 3 - Annualized changes: sample means and 95% confidence intervals for the populational means.

DISCUSSION

The present study aimed to evaluate the changes in the facial profile of pre-pubertal individuals with Class II, division 1, mandibular retrusion, treated with Balters' bionator. In order to discriminate alterations induced by treatment from those deriving from natural growth, a control group was used from the Burlington Growth Centre, Toronto, Canada, which did not receive orthodontic treatment.

The knowledge about the growth process and natural craniofacial development is essential for distinguishing changes that truly occur by means of the established treatment, from those that occur regardless of the use of orthodontic appliances. However, one

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of the major methodological difficulties in clinical research, in the field of orthodontics, is the composition of a control group orthodontically untreated with similar characteristics to the experimental group.[11] In the present study, it was used a control group from Canada, so it was possible to preserve the ethics, providing orthodontic treatment to all screened patients and eliminating a common bias for clinical work which is the absence of a control group.

In order to identify the actual stage of skeletal age, indicators of cervical vertebrae skeletal maturation were used based on the lateral teleradiographs, which are already part of the routine orthodontic records and therefore do not expose patients to additional X-rays,[24] as it happens when hand and wrist radiographs are requested. In this study, all individuals were located in stages 1 or 2 of maturation, i.e. before pubertal growth peak period.[4,21]

The assessment of equivalency between the experimental and control groups on measures targeted at baseline (Table 4) showed great cephalometric similarities before treatment between groups, since only 2 of the 11 variables were statistically different.

Finally, it will be discussed the changes on the facial profile that occurred due to the functional orthopedic treatment (experimental group) and without interference from any device (control group).

Effects of treatment

After the trial period of one year, it was observed that the supplementary angle to skeletal convexity (Convex) showed a nonsignificant reduction of 0.9º per year in the experimental group (Fig 3), while the control group did not change (0.0º per year), i.e. Balters' bionator provided a tendency towards improvement of facial convexity. These findings are in agreement with Melo[19] whose studies about the changes on skeletal angle of convexity (NAPg) showed an increase of 2.52º per year in children treated with bionator.

Considering that this angle is strongly influenced by the dislocation of the jaw bones during craniofacial growth and development, the behavior of anteroposterior jaw relative to the cranial base (SNA) was evaluated. It was identified that there was a tendency towards restriction of maxillary growth, known as extraoral effect, in the treated group (-0.6º per year), while the control group showed an increase of 0.4º per year (Fig 3). These data confirm the findings of Brandão[7] who verified the decrease of SNA in patients treated with bionator. As for the jaw, the SNB angle showed no statistically significant change.

The balance in the relation between the upper lip and the nose is quite evident by the nasolabial angle, which is often associated with the characterization of facial esthetics. In this experiment, there was an increase of 4.3º per year in the experimental group and 1.6º per year in the control group (Fig 3). The data shows that there was a tendency for this angle to become more opened in the group receiving treatment and are in agreement with the findings of Silva and Dominguez-Rodriguez,[28] who observed an increase of 9.83º per year on a sample treated with bionator.

A determinant factor in the nasolabial angle is the postural position of the upper lip, which was assessed by checking the inclination of the upper incisor (U1PP). In the treated group, it was found a decrease of 4.5º per year, highlighting the tendency towards vertical of maxillary incisors, whereas in the control group this decrease occurred on a much smaller scale (-0.6º per year). As for the lower incisors, they tended to proclination, with a not statistically significant slight increase of 1.5 mm per year in group 1 and 0.9 mm per year in group 2 (Fig 1). We also assessed the interincisal angle (U1L1), which confirmed these aforementioned findings, with an increase of 3.0° per year in the group receiving treatment and a slight increase of 0.2°per year in the untreated group. Despite of lower incisors proclination being an undesired side effect of this treatment, this may contribute to postural correction of the lower lip.[19]

Assessing the behavior of the supplementary angle to mentolabial (ML), it was observed a statistically significant decrease ($p < 0.05$) of 0.8 mm per year for the treated group, whereas there was a tendency to an increase of 0.1 mm per year in the control group (Fig 3). This means that there was a significant improvement in the mentolabial angle for the treated group. These results are in agreement with the study of Silva and Dominguez-Rodriguez,[28] who observed an increase of 6.85° in patients treated with bionator for 18 months. According to Blanchette et al,[6] the mentum/labial sulcus of Class II children, with horizontal growth pattern and not submitted to orthodontic or orthopedic treatment, deepens naturally, which can be explained by the lower lip retracted and positioned between upper and lower incisors.

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Evaluating the performance of the variable LAFH, there was a non-significant increase in the treated group of 1.4 mm per year, while in the control group this increase occurred in a lower manner (0.7 mm per year), which means that there was a trend to increased lower anterior facial height, a fact also confirmed by Melo,[19] who observed an increase in skeletal lower facial third of 1.37 mm per year in children treated with bionator.

Adding up the nose to the facial profile analysis, it was observed that the position of the upper lip to the line E (UL_E) showed a negative change of 0.8 mm per year (treatment group), while the control group did not show any alteration (0.0 mm per year). Then, there was a tendency to retrusion of the upper lip, a fact confirmed by Lange et al[17] who demonstrated the existence of an upper lip retrusion of 1.0 mm per year in patients treated with Balters' bionator. Regarding the lower lip (LL_E), there was a slight tendency to protrusion of the lower lip in both groups, being higher in the group that received no treatment (0.5 mm/year).

The statistical analysis at a significance level of 5% could not detect differences among most of the studied measures, except for the ML measure. It is noteworthy that, after a certain type of treatment, it is possible to find clinically detectable changes, but statistically insignificant, due to some factors such as the high variability of middle and/or high standard deviation, that may interfere on the effectiveness of the test used to identify these differences.

CONCLUSION

Considering the present study, it can be concluded that the effects produced by Balters' bionator on facial profile of children treated in the mixed dentition stage were:

- Increase of mentolabial angle.
- Tendency to decreased skeletal facial convexity.
- Tendency to maxillary growth restriction.
- Tendency to increased nasolabial angle.
- Tendency to verticalization of the upper incisors.
- Tendency to proclination of the lower incisors.
- Tendency to retrusion of the upper lip.
- Tendency to increased anterior facial height.

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Comparative study of the soft tissue of young Japanese-Brazilian, Caucasian and Mongoloid patients

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Objective: To determine the normality mean values in the soft tissue cephalometric measurements of young Japanese-Brazilian, with normal occlusion and compare the results of the variables with compatible samples of young Caucasians and Mongoloids.

Methods: Forty radiographs of young Caucasians, 32 of Japanese-Brazilians and 33 of Mongoloids were used. The three samples presented individuals with normal occlusion and well-balanced face. The samples were divided by gender due to the soft tissue characteristics and to facilitate comparison. The following statistical tests were performed: Analysis of variance (ANOVA) and analysis of covariance (ANCOVA) with $p < 0.05$.

Results: The Japanese-Brazilian sample of females showed thinner soft tissues in the nasion region and smaller nose when compared to the Caucasians. The Mongoloid sample showed thinner tissues in the supramentonian and pogonion regions. In males, the Japanese-Brazilians had thinner tissues in the nasion region; thicker lower lip and supramentonian region in comparison to the Caucasian sample. For the Mongoloid, soft tissue was thicker in the glabella and ANS-Sn regions.

Conclusion: It is necessary to use specific soft tissue standards for this mixed race.

Keywords: Ethnic groups. Reference values. Orthodontics.

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INTRODUCTION

Orthodontics has the cephalometric analysis as a great diagnostic aid. Since the advent of the cephalostat, many authors have focused on establishing analyses that facilitate orthodontic planning. These studies were initially conducted in Caucasians, but it has been shown that different races have different[12] cephalometric standards, thus making it necessary to establish normative values for the different racial and ethnical groups.

In multicultural societies such as Brazil, the racial differences have assumed great importance.[12] The Brazilian population is presented today with a lot of intermingled people, making it necessary to recognize that the best esthetic and functional results cannot be found when using as a guide another race or ethnicity.[22] Although many studies are found in the scientific literature about the soft tissue profile, there is no research on this subject comparing young Japanese-Brazilians with other races. Brazil is currently considered the country with the largest number of Japanese outside Japan and has different generations of nipponic origin,[27] and a lot of miscegenation, thus it is believed that a more specific study is necessary for this ethnic group.

This study aimed to determine the normality of mean values in the soft tissue profile of young Japanese-Brazilians, with normal occlusion, as well as Brazilians and Japanese descendants comparing these results with samples of young Caucasian Brazilians and young Mongoloid Brazilians.

MATERIAL AND METHODS

Material

The sample consisted of 105 radiographs of young Japanese-Brazilians, Caucasians and Mongoloids, with normal occlusion and balanced face. The Japanese-Brazilian sample was selected by 3 researchers in different schools of Bauru (Brazil), and the other two samples were collected from files of the Department of Orthodontics of the Bauru Dental School - University of São Paulo. The total study sample included 40 young Caucasians (20 of each gender), 32 young Japanese-Brazilian adults (17 females and 15 males) and 33 young Mongoloid adults (17 females and 16 males). The means and standard deviations of patients' ages are shown in Table 1.

All individuals had the upper and lower permanent teeth in occlusion, with or without second and third molars; showing a balanced growth pattern; harmonic profile, satisfactory occlusion or Angle Class I malocclusion with dental casts showing a discrepancy of up to 2 mm in the lower anterior region. None of them went through prior orthodontic treatment.

The Caucasian group consisted of Mediterranean descendents and the Mongoloid group of individuals with Japanese ancestries. These two samples did not include individuals of mixed heritage. For the Japanese-Brazilian group, the individuals should be children or grandchildren resulting from the union of Caucasian Brazilians and Japanese (Fig 1), not including individuals from the island of Okinawa, since it was colonized by Chinese people.

Methods

Cephalometric radiographs were taken from all sample individuals in maximum intercuspation (MHI), as it is known that the differences between this mandibular position and centric relation (CR) are minimal at this age, and they minimally interfere in the cephalometric results, especially in cases of normal occlusion.[30]

The cephalogram tracings and measurements were made by the same researcher. The images were scanned through a flatbed Numonics, AccuGrid A30TL (Numonics Corporation, Montgomeryville, PA, USA) connected to a PC with 700MHz Intel P3 processor, to obtain the cephalometric measurements, and subsequent data transfer to the Dentofacial Planner 7.02 software (Dentofacial Planner Software Inc., Toronto, Ontario, Canada). The correction of the magnification factor due to the use of different radiographic equipment (6% for the Caucasian sample, 9.8% for Japanese-Brazilian, and from 7% to 8% for the Mongoloid sample) was performed by the software itself.

After obtaining the lateral cephalometric radiographs, the anatomic design and location of classic cephalometric points was performed. To determine the linear horizontal measurements,[9,11,13] representing the soft tissue thickness, some measurements were made perpendicular to the N-perp line, taking the points of the soft tissue facial profile and their respective points in the dentoskeletal structures (Table 2, Fig 2).

Method error

Thirty days after the end of this stage, 20 radiographs were randomly selected and re-traced, manually and digitally, to determine result reliability. For each

Table 1 - Number of individuals (n) in each group, the distribution by gender, sample mean age and standard deviations (SD).

Groups	Total	Females	Males	Mean age	SD
Caucasian	40	20	20	13.64	0.97
Japanese-Brazilian	32	17	15	13.96	1.28
Mongoloid	33	17	16	15.61	2.44



Figure 1 - Extraoral photographs of young Japanese-Brazilian female.

Table 2 - Linear horizontal measurements.

Nº	Name (Abbreviation)	Definition
1	Thickness of the glabella soft tissue (Gl-GL')	Distance between the hard tissue and the soft tissue glabella points
2	Nasion soft tissue thickness (N-N ')	Distance between the hard tissue and the soft tissue nasion points
3	Nasal thickness (Prn-Nperp)	Distance between the pronasal point and its perpendicular projection to the N-perp line
4	Nasal projection (Sn-Prn)	Horizontal distance between the subnasale and pronasale points
5	Thickness of the subnasale region (ANS-Sn)	Distance between the anterior nasal spine and subnasale points
6	Soft tissue thickness of the anterior maxillary region (A-A')	Distance between points A and A'
7	Upper lip thickness (ULp-UL)	Distance between the UL point and its projection on the upper incisor[11]
8	Lower lip thickness (LLp-LL)	Distance between LL point and its projection on the lower incisor[11]
9	Thickness of the mentolabial sulcus (B-B')	Distance between points B and B'
10	Anterior thickness of the soft tissue mentum (Pog-Pog')	Distance between the hard tissue and the soft tissue pogonion points

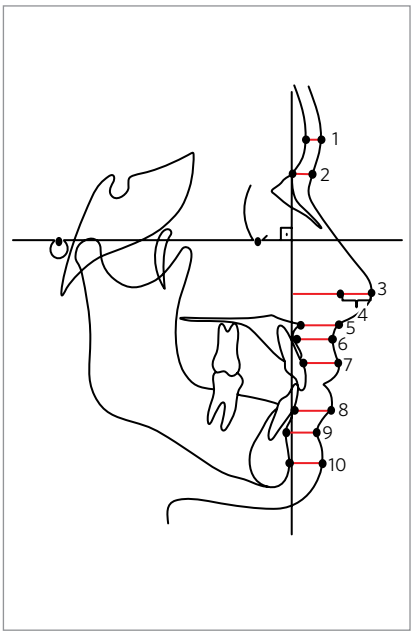


Figure 2 - Horizontal linear measurements.

one of the cephalometric measurements, the systematic and random errors were evaluated, independently. The *t* test was used to calculate the dependent systematic error at a significance level of 5%. To estimate the random error, the formula proposed by Dahlberg ($Se^2 = \Sigma d^2/2n$) was applied, where Se^2 is the error variation, d is the difference between the first and second measurement and n is the number of double measurements.

Statistical analysis

Descriptive statistics was used (mean and standard deviation). The Kolmogorov-Smirnov test demonstrated normal distribution for all variables allowing the use of parametric tests. Thus, for comparative statistical analysis of the data, the following parametric tests were used: ANOVA, analysis of variance with a criterion for comparison of ages, and Ancova, analysis of covariance for comparison of cephalometric variables between the samples (Caucasian, Japanese-Brazilian and Mongoloid).

Due to the lack of age compatibility in the samples, the analysis of covariance (ANCOVA) was used to verify the influence of age on the results. The analysis of covariance aims to assess the effect of one or more explanatory factors rated in nature (in this research, the race) in a given variable, excluding the influence of possible quantitative factors (in this case, the age) that may influence the variables. The results were considered statistically significant for $p < 0.05$. The tests were performed using the Statistica software for Windows 6.0 (Statistica for Windows 6.0, Copyright StatSoft, Inc. Tulsa, USA).

RESULTS

The systematic and random errors are shown in Table 3. Only two variables showed a systematic error and for the random error all variables showed acceptable values of less than 1 mm (Table 3). There were significant differences regarding age for both genders (Table 4) and for this reason the analysis of covariance was performed (Tables 5 and 6).

Table 3 - Evaluation of systematic and random errors by dependent t test and Dahlberg's formula.

Variable	1st tracing		2nd tracing		p	Dahlberg
	Mean	SD	Mean	SD		
Soft tissue thickness (mm)						
Upper face						
Gl-GL'	5.93	0.96	5.90	0.93	0.746	0.31
N-N'	5.56	1.47	5.38	1.40	0.273	0.43
Midface						
Prn-Nperp	26.98	2.64	26.86	2.57	0.729	0.97
Sn-Prn	12.05	1.37	12.11	1.38	0.245	0.32
ANS-Sn	10.31	3.51	9.95	2.98	0.384	0.96
Lower face						
A-A'	13.98	2.88	14.97	2.88	0.098	0.89
ULp-UL	14.39	2.21	13.78	1.98	0.032*	0.84
LLp-LL	14.66	1.72	14.23	1.57	0.039*	0.62
B-B'	12.17	1.59	12.35	1.61	0.294	0.45
Pog-Pog'	11.71	1.41	11.69	1.37	0.946	0.47

* Statistically significant at $p < 0.05$.

Table 4 - Comparison of mean ages between the different races, in males and females included in the samples, by analysis of variance (ANOVA).

Gender	Caucasian			Japanese-Brazilian			Mongoloid			p
	n	Mean	SD	n	Mean	SD	n	Mean	SD	
Female	20	13.70[a]	0.87	17	13.22[a]	1.04	17	15.65[b]	2.44	0.000*
Male	20	13.57[a]	1.03	15	14.79[a,b]	1.01	16	15.56[b]	2.51	0.002*
Total	40	13.63[a]	0.97	32	13.96[a]	1.29	33	15.61[b]	2.44	0.000*

* Statistically significant at $p < 0.05$
Different letters show significant differences between means by Tukey test.

Table 5 - Comparison of variables between the female samples (ANCOVA and Tukey's test).

Variable	Caucasian (n = 20)		Japanese-Brazilian (n = 17)		Mongoloid (n = 17)		p Age	p
	Mean	SD	Mean	SD	Mean	SD		
Soft tissue thickness (mm)								
Upper face								
Gl-GL'	5.87	0.49	6.01	0.68	5.94	0.87	0.196	0.652
N-N'	7.01[a]	0.88	6.14[b]	1.19	5.87[b]	1.01	0.744	0.005*
Midface								
Prn-Nperp	28.83[a]	3.75	26.35[a,b]	2.52	24.90[b]	3.29	0.939	0.005*
Sn-Prn	14.52[a]	1.45	12.01[b]	1.48	11.73[b]	1.66	0.128	0.000*
ANS-Sn	10.07	1.93	9.64	1.48	8.84	1.96	0.504	0.115
Lower face								
A-A'	14.38[a]	1.92	13.10[a,b]	1.58	12.65[b]	1.45	0.941	0.010*
ULp-UL	12.80	1.35	13.50	1.85	12.66	1.86	1.000	0.386
LLp-LL	13.82	1.09	13.79	1.19	14.11	1.63	0.555	0.944
B-B'	11.23[a]	1.49	10.71[a]	0.63	13.02[b]	1.84	0.475	0.002*
Pog-Pog'	11.47[a]	1.26	11.22[a]	1.36	12.25[b]	2.20	0.002*	0.003*

Different letters show significant differences between means by Tukey test.
* Statistically significant at $p < 0.05$.

Table 6 - Comparison of variables between the male samples (ANCOVA and Tukey's test).

Variable	Caucasian (n = 20)		Japanese-Brazilian (n = 15)		Mongoloid (n = 16)		p Age	p
	Mean	SD	Mean	SD	Mean	SD		
Soft tissue thickness (mm)								
Upper face								
Gl-GL'	5.91[a,b]	1.04	6.54[a]	0.81	5.69[b]	0.65	0.478	0.026*
N-N'	7.93[a]	1.00	6.56[b]	1.09	6.08[b]	1.12	0.455	0.000*
Midface								
Prn-Nperp	28.50	3.38	29.56	3.18	26.72	3.13	0.304	0.090
Sn-Prn	13.02	2.44	13.43	2.05	13.32	1.54	0.432	0.938
ANS-Sn	11.37[a]	2.27	11.17[a]	2.26	9.52[b]	2.21	0.369	0.033*
Lower face								
A-A'	15.60	1.95	15.76	2.02	14.58	1.49	0.936	0.268
ULp-UL	14.24	1.78	15.06	1.66	14.17	2.34	0.071	0.298
LLp-LL	14.88[a]	1.21	16.60[b]	1.74	16.77[b]	2.17	0.745	0.008*
B-B'	11.23[a]	1.07	12.68[b]	1.30	13.68[b]	1.49	0.142	0.000*
Pog-Pog'	12.18	1.69	12.95	1.49	12.64	2.14	0.277	0.252

Different letters show significant differences between means by Tukey test.
* Statistically significant at $p < 0.05$.

DISCUSSION

The same appearance is not always appropriate for all races and ethnic groups, however, normative studies of cephalometric variables are important for precisely determining the variations of what is normal.[22] There are some studies about soft tissue in Caucasians and Mongoloids, but no specific study about Japanese-Brazilians and the comparison of these three groups. Besides, it is difficult to compare cephalometric studies in different races due to sample characteristics, statistical methods, geographic distribution and racial definitions. The groups that were used in this study met the same inclusion criteria, especially regarding race, which was strictly evaluated.

Some studies explained that when analyzing the soft tissue profile, it is necessary to differentiate the

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variables for men and women.[4,17] The subdivision by gender and racial group has received support in other studies,[14,22] that emphasized that the accurate use of cephalometrics, should consider these aspects. In this study, the genders were analyzed separately for better comparison of soft tissue profile.

Thickness alterations on the soft tissue profile vary with age and gender.[29] Besides this fact, the dento-skeletal changes can directly influence the desired esthetics. The soft tissue may also vary in thickness, length and position, which makes the study of the outline of these tissues necessary, in order to achieve a total facial harmony.[8] According to Arnett et al,[4] the thickness measurements of the upper lip, lower lip, point B region, pogonion, and chin alter the facial profile. As well as the variation of lip thickness, especially during retraction or dental protraction.[8] Differences found in the soft tissue profile in this study can be seen in the pictures of the mean profile of the three samples (Figs 3A and B).

Only the variables that showed statistically significant difference after comparison with a sample of Caucasian and Mongoloid, will be discussed (Tables 5 and 6). These magnitudes were grouped according to their representation and to facilitate the understanding, divided into upper, middle and lower face. The results are discussed focusing on the Japanese-Brazilian sample and their differences to the Mongoloid and Caucasian samples.

Upper face

Considering the upper face a difference was observed in the thinnest region of the nasion (N-N') for the Mongoloid (female 5.87 mm, female 6.08) and Japanese-Brazilian groups (female 6.14 mm, 6 male, 56 mm) when compared to the Caucasian sample (female 7.01 mm, 7.93 mm female). This may be related to the fact that the soft tissues of the Japanese individuals in these regions are more firmly attached and have

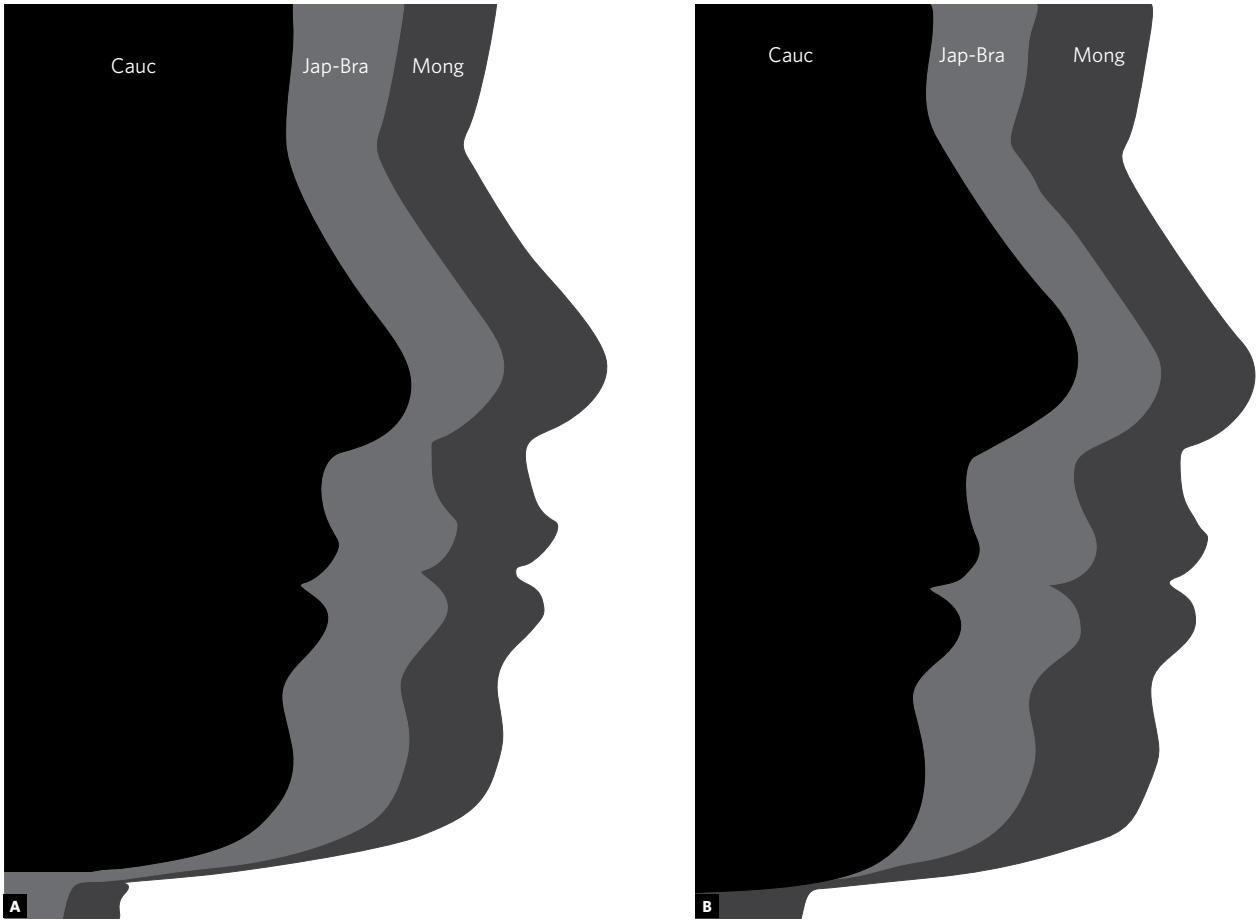


Figure 3 - Illustrative comparison of the profile means between Caucasian, Japanese-Brazilian and Mongoloid groups: (**A**) female, (**B**) male.

more subtle growth when compared to the Caucasian sample.[29] The expectation that Japanese descendents have a flatter area in the region of the nasion and this appearance can be associated to a thinner soft tissue is, therefore, confirmed.

Also regarding the upper face, males of the Japanese-Brazilian sample showed statistically higher values of soft tissue thickness (6.54 mm) in the glabella region (Gl-Gl') when compared to the Mongoloid sample (5.69 mm). This increased thickness emphasizes even more the flattening found for Japanese-Brazilians in the region of nasion (N-N'). This variable quantifies the thickness in the nasion region and presented particular characteristics regarding the ethnicity for both genders. In most cases, the thickness in the nasion region is greater in men than in women and in both genders, the thickness of this area tends to remain constant or decrease slightly with age.[25,29]

Although the upper face area is not an area of direct action for the orthodontist and it will not be changed with orthodontic treatment itself, the practitioner must be aware of the general profile aspect.

Midface

As for the thickness of soft tissues in this region in females, it was observed that the Japanese-Brazilian sample showed intermediate values for variables Sn-Prn and Prn-Nperp. When compared to Caucasians (14.52 mm), statistically lower values for the size of the nose (Prn-Sn) were found in the Japanese-Brazilian sample (12.01 mm) and Mongoloids (11.73 mm), which can be confirmed by previous findings that Asians have smaller noses when compared to other populations.[1] Corroborating with these findings, the smallest nose size was also evidenced by the variable Prn-Nperp in the Mongoloid sample (24.90 mm) when compared to Caucasians (28.83 mm).

The only variable for males that showed a significant difference in this region of the face was the ANS-Sn which showed intermediate values for Japanese-Brazilians (11.17 mm) but similar to the values found for the Caucasians (11.37 mm). This variable is also related to the nose and confirmed the trend of Mongoloids having smaller noses (9.52 mm) when compared to other races.[1,24] As the amount of increase in nasal projection (Prn-Nperp and Sn-Prn) in boys occurs in older ages,[6,8] it is speculated that this is the reason for the lack of difference for this gender in this research, since Japanese individuals, even older, show a smaller nose (26.72 mm) when compared to other samples.

Angle, in his book published in 1907, stated that the amount of nose development may influence the final treatment result, and correction of isolated dental disharmonies can often detract the profile.[13] Thus, the nose size is a factor that should be evaluated in terms of treatment[25] because irreversible procedures such as extractions and retractions may affect facial profile esthetics.

Lower face

The lower face is the actual area of orthodontic action and this requires strict evaluation, which justifies the fact that most of the variables in this study are related to this region.

Subspinale region (A-A')

The thickness of the subspinale region (A-A') directly affects the shape of the soft tissue profile and only females showed significant differences between the races. The Caucasian sample showed the highest value (14.38 mm) and it is known that the increased thickness of soft tissues in this region, may mask a dental protrusion.[9] In this Japanese-Brazilian sample, the thickness was numerically intermediate (13.10 mm) and the lowest value was found in the Mongoloid sample (12.65 mm) which, associated to the small nose in this group, may evidence even more a lip protrusion in Japanese descendents.

According to Subtelny[25] the thickness of this region grows on average 5 mm, from 3 to 18 years old, and comparatively, there is more soft tissue covering point A region then there is covering the nasion and pogonion regions. This was also found in this study for all samples, in both genders. Thus, the soft profile tends to change more in the direction of increased thickness than in the reduction of facial convexity. This may partly explain why the soft tissue, without the inclusion of the nose, tends to get progressively less convex over the age, as occurs in the skeletal profile.[25]

Lower lip (LLp-LL)

Assessing the region of the lower face in males (Table 6), attention is drawn to the thickness of the lower lip (LLp-LL), which was higher in Japanese-Brazilians (16.60 mm) and Mongoloids (16.77 mm). This thick-

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ness probably also contributes to the appearance of a more convex profile in the Asian descents.[28] The increased thickness of the lower lip can mask a Class II relation and promote a more straight profile, bringing at least esthetic benefits to Asian descendants with malocclusions such as these.

Over the years, the lips suffer a redirection that causes a wilted appearance. The decrease in thickness is compensated with a proportional increase in height of the lips, allowing the volume to remain the same.[15] Based on this, fact, orthodontic planning can be established more thoroughly in young patients with gingival smile, considering these changes during growth.

The thickness, height and position of the lips, particular characteristics of the individuals, can influence the response of the soft tissue to retraction movement. Patients with thicker lips respond differently to orthodontic treatment than patients with thinner lips.[20] Patients with thinner lips have a higher correlation between changes in hard tissue and these changes' reflect in the soft tissue. It is important to note that orthodontists should be aware of the thickness of the lips in the treatment plan, not to overestimate the changes that may occur in soft tissue.

Supramentonian region (B-B') and pogonion (Pog-Pog')

Japanese-Brazilian girls had less thickness in the supramentonian region (10.71 mm) and the Mongoloid sample had more thickness (13.02 mm) in this region. In this aspect, the girls had similar characteristics to the Caucasians. Unlike males, the supramentonian region (B-B') showed greater thickness in Japanese-Brazilians (12.68 mm) and Mongoloids (13.68 mm), which contributes to a straighter mentolabial sulcus. For these races, the greater thickness of the lower lip and mentolabial sulcus features, emphasize the care that the orthodontist should have with relapses, since it is known that muscle behavior, depending on the intensity, has a greater chance of recurrence[7] and more stretched muscles tend to act even more.

The pogonion region for girls was statistically significant, both for the race factor as for the age factor, suggesting the need for attention to this variable, because the difference occurs even for the same ages. A smaller thickness of this region for the Japanese-Brazilians (11.22 mm) and greater for the Mongoloid sample (12.25 mm) was found, which is also the sample of older people. Thus, the greater thickness of this area, may be related to higher mean age of Japanese women (15.65 years), since the tendency is that the pogonion thickness increases with age, when evaluating only the thickness itself.[5,21]

The previous aspects clearly show that soft tissues do not form a layer of uniform thickness that simply molds to the configuration of the underlying dentoskeletal structures. Therefore, it must be considered that individual variability on the thickness of soft tissues may reflect greatly on facial profile harmony, making the evaluation of this factor necessary during the diagnosis and planning of orthodontic treatment.[8]

FINAL CONSIDERATIONS

When performing comparisons such as the one performed in this study, it is emphasized that people should not be obsessed with numbers, but should observe the characteristics of each person. It is known that the period and environment in which people live has a direct influence on the concept of beauty. Alcalde et al[2] reported that Japanese living in Japan, have different expectations regarding the treatment of those living in other regions of the world, due to their social differences and cultural influences. Still, Miyajima et al[19] reported the revival of a sense of ethnic pride, especially in big cities. Besides, patient demands have increased in the search of an exclusive orthodontic treatment, which is based on standards derived from their race or specific ethnic group.[16]

Given the anthropological differences of facial and dental standards, Miura, Inoue and Suzuki[18] concluded that, besides having different values, the treatment target for the Japanese should also be different from the Caucasian. Although respecting the patient's expectations, it is important to make them aware of the effects that certain changes may bring. Many times, what is normal for a race may not be so for another race, and this has to be considered. In clinical terms, it is known that besides the labial biprotrusion, it is normal for the Asian descendants to show dental double protrusion[1,16,23,26] Thus, a combination of different individualized brackets prescriptions[10] could allow a satisfactory final result for this race, because the requirements for Class II malocclusion cases have more buccal torque for the lower incisors and those

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used for Class III malocclusion have greater buccal torque for the upper incisors.[10]

Recognizing that racial influences and characteristics have an important role in guiding the goals of orthodontic treatment and their esthetic results is critical to understand the value and necessity of individualized orthodontic treatment and the study of specific standards for each ethnic group. Thus, common sense should prevail, since it is often not possible to achieve the "ideal standard". The amount of tooth movement, tissue damage and increased risk of recurrence may contraindicate an action that seeks only the rigorous esthetic imposed by social environment. It is necessary to safeguard the conditions of muscle balance and notice what is acceptable for each individual.

CONCLUSION

Based on the methodology and results of this research, it can be concluded that the mixed race sample of Japanese-Brazilians has its own characteristics, such as:

» Females:
- Reduced thickness in the nasion and lower nose regions in relation to Caucasians.
- Reduced thickness in the supramentonian and pogonion regions compared to Mongoloids.

» Males:
- Reduced thickness in the nasion region, greater thickness of the lower lip and the supramentonian regions in relation to Caucasians.
- Greater thickness in the glabella and the ANS-Sn regions compared to Mongoloids.

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Assessing the predictability of ANB, 1-NB, P-NB and 1-NA measurements on Steiner cephalometric analysis

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Objective: To evaluate, in the initial and final stages of corrective orthodontic treatment, the predictability of the ANB, 1-NB, PNB and 1-NA during case individualization, which considers the characteristics of the patient, professional experience and the mechanics to be used.

Methods: Ninety patients were selected at the State University of Londrina (UEL, Brazil), presenting Angle Class I and II malocclusions, treated with and without extraction of four premolars and divided into three groups: Horizontal, balanced and vertical. The cephalometric variables were evaluated in the initial, prognosis and final stages of treatment in order to observe the behavior of the estimates, or how they were higher or lower than the values obtained.

Results: It was noticed the influence of the facial pattern on the behavior of the measures examined, the values proposed for the ANB were statistically different from values obtained at the end of the treatment; in the vertical group the final value was the one that most approached the proposed value; regarding 1-NB the values proposed with the Steiner analysis for the balanced and vertical groups were not achieved. For P-NB, there was no difference between genders. For 1-NA it was observed that the values obtained at the end of treatment differ from estimates in the three groups.

Conclusions: The limitations of the estimates of the measures do not invalidate its clinical or teaching use, if aware of its deficiencies, the analysis can be used with restrictions.

Keywords: Growth and development. Radiography. Tooth movement.

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INTRODUCTION

With the development of the cephalostat and the consequent standardization of the radiographs, in 1931, it became possible to carry out several cephalometric analyses based on average angular and linear values, obtained from individuals with normal occlusion and a satisfactory facial profile.[4,12] These values allow for comparisons with those from the patient, verifying the skeletal and dental pattern and the structures that show discrepancies from the norms, thus making diagnosis and the development of individualized treatment plans possible.[27]

In the mid 40's, Tweed included the movement of the lower incisors in the planning of clinical cases, with the purpose of obtaining an ideal occlusion after an orthodontic treatment. He described that these teeth should present a 90° angle to the mandibular plane, with a tolerable variation of around +5°.

In 1948, Downs[6] determined nine angular and one linear measurement, which described the skeletal and dental patterns of Caucasian North Americans, with an excellent clinical occlusion, thus carrying out the first systematic cephalometric analysis. For the author, despite the considerable variation in type and facial pattern, in order for individuals to present a good functional and esthetic balance, they should possess certain common characteristics of the profile.

Realizing that most orthodontists did not call upon cephalometry as a clinical diagnosis resource, since they saw it as a purely scientific instrument used for research purposes, Steiner,[25-28] in the following decade, proposed an analysis based, empirically, on the dentoalveolar compensatory mechanism, which helped professionals to determine the nature of the bad occlusion, making the development of treatment plans more objective. Using the analyses of Downs, Margolis, Riedel, Thompson, and Wylie, combined with some of his own cephalometric values, he established his own analysis for young leucoderms of Anglo-Saxon origin from the United States.

When arguing the value of Steiner's analysis, one must bear in mind the references and the choices available at that time. Jaw functional orthopedics was incipient and not very propagated amongst American orthodontists, therefore, it did not emphasize orthopedic problems such as the lower facial height, the relative length of the jaw and mandible, the facial convexity angle or the measurements of the posterior cranial base.[25-28]

Steiner's analysis was well accepted by many researchers who, mindful of the occurrence of variations related to the different ethnic and racial groups,[27,28] set out to verify if the values proposed by Steiner could be applied to different population groups. Several studies, mainly in relation to the dental patterns proposed by Steiner (1-NA = 4 mm and 1-NB = 4 mm), have demonstrated different values from the proposed norm.[1,9,16,21,23,29] Some authors, concerned with better analyzing and planning their cases, established the ideal cephalometric norms and the acceptable compromises of this analysis to different racial and ethnic groups.[29]

To develop a treatment plan, along with anamnesis and clinical analysis, some diagnostic elements are fundamental, as study models, intraoral x-rays, extraoral X-rays (panoramic and cephalometric) and intraoral and extraoral photographs. Each diagnostic element presents different ways of evaluation. For that purpose, we have used Steiner's analysis to estimate the qualitative and quantitative growth, with a view to establish treatment goals, thus becoming an important tool for the elaboration of treatment plans. Despite being an important tool for the clinician, it presents a certain degree of subjectivity, when it comes to estimating each patient's growth.

The result of an orthodontic treatment can sometimes be distorted by the stubbornness of some researchers who insist on the fact that the statistical averages should match the final objective of the treatment. This has determined the elaboration of this study with the purpose of analyzing, in the final phase of corrective orthodontic treatment, the predictability of the measurements ANB, 1-NB, P-NB, and 1-NA, estimated on the individualization of Steiner's analysis, considering horizontal, balanced and vertical growth patterns.

MATERIAL AND METHODS

Material

Sample collection

We randomly evaluated 300 patient files obtained from the Londrina State University Orthodontics Specialization Course databank and analyzed two lateral cephalometric radiographs from each file, totaling 600 x-rays from patients with Class I and Class II Angle malocclusions, who had their treatment ended. From the initial total of 300 files we selected 90, from which 36 were male and 54 female, to compose the final sample.

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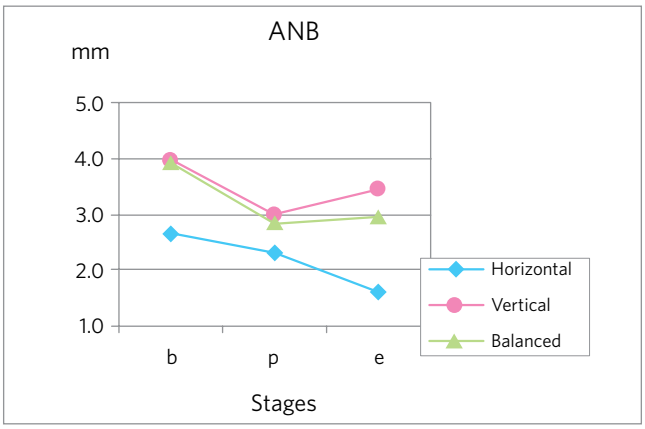


Figure 1 - Average behavior for ANB at the beginning (b) and at the end (e) of treatment, mediated by the proposed value (p).

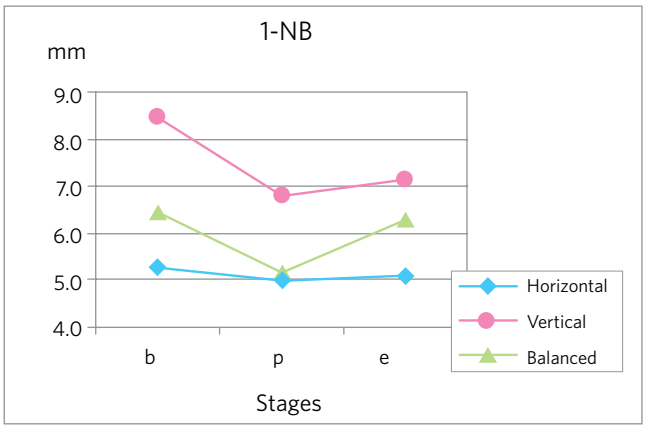


Figure 2 - Average behavior for 1-NB at the beginning (b) the end (e) treatment, mediated by the proposed value (p).

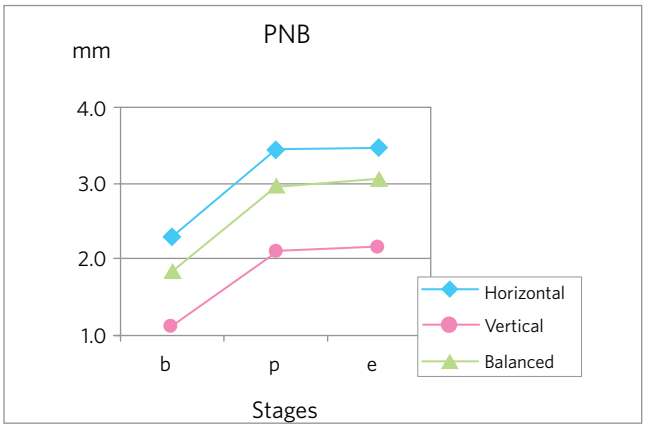


Figure 3 - Average behavior of PNB at the beginning (b), at the end (e) of treatment, mediated by the proposal (p).

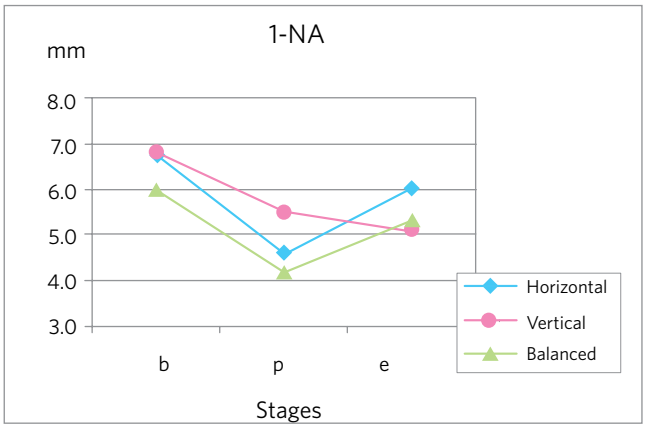


Figure 4 - Average behavior 1-NA at the beginning (b) and at the end (e) of treatment, mediated by the proposal (p).

ANB, 1-NB, P-NB and 1-NA cephalometric measurements were collected from the patients' files and the individualizations were done by Professors from the Course of Orthodontics, Londrina State University. After the analysis, the research was approved by the Ethics Committee under CEP opinion nº 042/08. The following inclusion factors were considered for sample selection.

Inclusion factors

» Patients with Angle Class I and Class II malocclusion, treated with or without extractions.
» Patients with no deleterious oral habits.
» Cases that were well finished, both esthetically and functionally, with complete initial and final records.
» Patients treated at the Orthodontics Specialization Course of the Londrina State University.
» Lateral cephalometric radiographs taken with a Polomex-Siemens cephalometric device, model Orthopantomagraph 10E-0P10-EE60-Uel 73180, serial number 62249, Yoshida-Cephlo. expure, manufacturing/inclusion year 1992;

Since one of the criteria to estimate values during the individualization of each case consists of the evaluation of the growth pattern and that this pattern (dolichocephalic, mesocephalic and brachycephalic) exerts a greater influence on growth than the anterior-posterior relation (Class I and Class II), the sample was divided, according to the craniofacial growth in three groups:

» Horizontal group (H): 11 female and 3 male.
» Balanced group (E): 11 female and 14 male.
» Vertical group (V): 32 female and 19 male.

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The craniofacial growth pattern was established using SN.GoGn cephalometric measurements. Despite the existing controversy in the literature related to the reliability of the Sela-Nasio line, we opted for this measurement, mainly because it was advocated by Steiner[25,26,27,28] in his cephalometric analysis proposition.

The Craniofacial Growth Atlas, published by Martins et al[15] was used to divide the groups, since it offers the average values and their respective standard deviations from the selected measurement, and it was elaborated on a sample of Brazilians of Mediterranean descent. Since the corrective orthodontic treatment begins at around 12 years of age, the values for SN.GoGn were checked at that age, obtaining the measurements of 33.20 for the female genre and 34.30 for the male genre, and the limits for the balanced group of 28.20 to 38.20 for females and 30.30 to 38.60 for males. The horizontal group was classified from values below the inferior limits, and the vertical, above the superior limits.

Cephalometric growths were evaluated in the initial, proposed and final phases of the treatment. We also verified the differences between the final and the proposed phases to observe the behavior of the estimates, checking how higher or lower they were compared to the obtained values.

RESULTS AND DISCUSSION

Since Steiner's analysis is used all over the world and is considered an important tool for teaching and for the systemization of diagnosis and the elaboration of treatment plans, we tried, with this research, to establish a critical view of the way in which the analysis is being employed, as well as possible adjustments that the results of the research might suggest.

Predictability of the ANB angle

By observing the behavior of the initial and final ANB angle, we realized that it became smaller with age, more significantly in the horizontal group, and not in the vertical and balanced groups, whose final value was higher than the proposed value, which corroborates with the findings of Bishara,[3] Coura et al,[5] Silva et al[24] and the Craniofacial Growth Atlas.[15]

The proposed values for the initial and final ANB angles (Fig 1 and Table 1) were statistically different from the values obtained at the end of the treatment, with the exception of the balanced group. In reality, there was a greater variation only in the horizontal group, different from the results found by Ortiz et al[18] whose final values were similar to the proposed estimates.

The horizontal group had the proposed value for the ANB angle higher than the final value from all the groups. This probably occurred due to the greater potential for mandibular growth, contributing to the reduction of this angle.

Results obtained by this research for the ANB angle corroborates with the findings of Farret[7] and Ortiz et al,[18] who utilized a similar methodology and obtained values that were very close to the proposed at the end of the treatment.

When comparing the three groups studied in relation to gender interference in the resulting values, results from the analysis of variance (ANOVA) showed no differences between them. This shows that the main effect, observed only in the horizontal group, is distributed equally between the male and female genders.

By comparing ANB angle averages at the initial and final phases with the proposed phase, we verify, through the paired *t* test, that there was a significant statistical difference between the proposed and the final stages of treatment (Table 1).

Rate of accuracy was reduced in the three groups, showing greater tendency to underestimate the reduction of the ANB angle, mainly in the horizontal group, which has greater growth potential (Table 2). Meanwhile, in the differences averages between the final and the proposed phases, the numeric values were clinically low.

From these results, it is possible to find the deficiency in the individualization of the estimates, mainly for the horizontal group, which leads to the need to avoid the underestimation of the mandibular growth potential with this age group and with both sexes. Based on these results, one can state that the ANB estimates have limitations and should not be taken as rigid parameters for the finishing of orthodontic treatment.

Predictability of the 1-NB measurement

The Holdaway principle, where the distances P-NB and 1-NB must be equal or vary within a 2 mm limit, was introduced by Steiner[26] in his analysis in 1959. This proportion was analyzed with young Brazilians, with normal occlusion and its use during diagnosis and treatment plan developments is indicated in literature.[7]

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Silva and Martins[24] conducted a study with young Caucasian Brazilians with normal occlusion, demonstrating that the 1-NB measurement for this population is larger than the ideal values advocated by Steiner.[25,26,27,28]

In relation to the 1-NB measurement (Fig 2), results from this study shows that in the balanced and mainly in the horizontal group, a retrusion of the lower incisors is proposed, while in the horizontal group it was estimated that the lower incisors practically did not suffer any changes in relation to their angles of protrusion. At the end of the treatment, we observed retrusion in all groups, however, the proposed values during the elaboration of Steiner's analysis for the balanced and vertical groups were not reached. A similar behavior was observed by Farret,[7] who also verified a tendency to underestimate the values of the 1-NB measurement (averages obtained for 1-NB proposed 3.62 mm and final 4.98 mm), concluding that the use of Steiner's analysis must be carried out with great caution and criteria for Brazilians with Class I occlusions, since the acceptable compromises underestimate the average position of the incisors.

Ramos et al,[22] and Hasund[11] emphasize the importance of taking into consideration the fact that the 1-NB measurement is larger in the cases where the growth pattern is divergent and smaller than a convergent growth pattern, during the elaboration of Steiner's analysis.

In the current evaluation, we verify a significant statistical difference between the proposed values and the ones obtained at the end of the treatment for the vertical and balanced groups (Table 3). We observed that these values were underestimated, just as in the studies of Farret[7] and Pinzan et al,[20] since the estimated P-NB for both groups did not present a significant difference in relation to the obtained value, and the value of 1-NB appeared higher for youths with a vertical growth pattern.[11,22]

Table 1 - Test result for the comparison between proposed values (p) and the values at the end of treatment (e) for the ANB angle.

Facial type	Initial average	Proposed average	Average after treatment	Difference e-p	p- value	Test
Horizontal	2.65	2.30	1.60	-0.70	2.9%	Student *t* test
Vertical	3.96	3.00	3.43	0.43	23.37%	Student *t* test
Balanced	3.93	2.82	2.96	0.14	54.68%	Student *t* test

Table 2 - Number and rate of accuracy (=) of the proposed value, of a larger final value (>), or smaller (<) than the estimates of the ANB measurement (e-p).

Groups	Accuracy =	Larger >	Smaller <	Total
Horizontal	6 (24%)	7 (28%)	12 (48%)	25
Balanced	9 (17%)	22 (43%)	20 (39%)	51
Vertical	3 (22%)	7 (50%)	4 (28%)	14

Table 3 - Comparison between proposed values (p) and the values at the end of treatment (e) for 1-NB.

Facial type	Initial average	Proposed average	Average after treatment	Difference e-p	p-value	Test
Horizontal	5.26	4.96	5.10	0.14	68.22%	Student *t* test
Vertical	8.46	6.79	7.11	0.32	85.55%	Wilcoxon
Balanced	6.41	5.14	6.27	1.13	0.01%	Wilcoxon

Table 4 - Number and rate of accuracy (=) for the proposed value, for a larger final value (>), or smaller (<) than the estimates of the 1-NB measurement (e-p).

Groups	Accuracy =	Larger >	Smaller <	Total
Balanced	6 (24%)	9 (36%)	10 (40%)	25
Balanced	9 (17%)	34 (66%)	8 (15%)	51
Vertical	3 (22%)	7 (50%)	4 (28%)	14

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Table 5 - Comparison between the proposed values (p) and the values at the end of treatment (e) for P-NB.

Facial type	Initial average	Proposed average	Average after treatment	Difference e-p	p-value	Test
Horizontal	2.3	3.44	3.48	0.04	85.33%	Student *t* test
Vertical	1.10	2.11	2.18	0.07	82.10%	Student *t* test
Balanced	1.85	2.97	3.07	0.10	56.22%	Signs of posts

Table 6 - Number and accuracy rate (=) of the proposed value, of a larger final value (>) or smaller (<) than the estimates of the P-NB measurement e-p).

Groups	Accuracy =	Larger >	Smaller <	Total
Horizontal	3 (12%)	10 (40%)	12 (48%)	25
Balanced	8 (15%)	19 (37%)	24 (47%)	51
Vertical	3 (22%)	6 (42%)	5 (35%)	14

By evaluating the behavior of the 1-NB estimates considering the growth pattern and/or gender, we verified, in the balanced group, the same behavior for both genders. For the horizontal and vertical groups, we verified that, at the end of the orthodontic treatment, horizontal individuals of the female gender presented 1-NB larger than the proposed, horizontal individuals of the male gender presented 1-NB smaller than the proposed, vertical individuals of the female gender presented 1-NB smaller than proposed, and, finally, vertical individuals of the male gender presented 1-NB larger than the proposed. Thus, we have an inverted behavior between men and women, according to their facial type. Gender influence was also found by Pinzan,[20] but only in the vertical group.

The rate of accuracy was low for all facial types, where the margin of error for high values was higher in the balanced group, lower for the horizontal group and also higher for the vertical group (Table 4).

Since Steiner's acceptable compromise table underestimates the positioning of the lower incisors for young Caucasian Brazilians, we emphasize the need to individualize the values for this population.

Predictability of the P-NB measurement

The P-NB measurement was considered indispensable by Steiner[26] in his analysis, however, he did not specified the factors that subsidized his calculations, emphasizing the role represented by the clinical experience, pattern, growth potential and gender of the patient.

Holdaway's 1:1 proportion, with a tolerance limit of 3 mm, was verified in young Brazilians with normal occlusion, and, therefore, its use during the diagnostic and treatment plan elaborations is indicated in literature.[7,17]

By analyzing the P-NB measurement in all its stages, we verified, through Figure 3, that there was no difference between the proposed and the end values in all studied groups, which was also verified by Ramos et al.[2] However, they emphasize that the occurrence of individual variations in this region might have masked the P-NB's tendency to be smaller in the vertical group.

Bishara et al[2,3] described higher values for the P-NB in horizontal patients and lower in vertical ones, which is explained by Bishara,[2] and influenced by jaw rotation. Pinzan et al[19] found differences in their study for the proposed values in relation to the end-of-treatment values in the horizontal and balanced groups, whilst in the vertical group this difference was not noted. By comparing the averages of the P-NB in the initial and final stages with the proposed stage, we verified, through the paired "t" test, that there was no statistically significant difference between the proposed and final stages of treatment, determining a correct growth estimate in the anterior region of the chin[8] (Table 5). We observed no

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Table 7 - Number and accuracy rate (=) of the proposed value, of a final larger value (>) or smaller (<) than the estimates of the 1-NA measurement (e-p).

Groups	Accuracy =	Larger >	Smaller <	Total
Horizontal	1 (4%)	17 (68%)	7 (28%)	25
Balanced	10 (19%)	10 (19%)	31 (60%)	51
Vertical	2 (14%)	6 (42%)	6 (42%)	14

Table 8 - Test result for the comparison between the proposed values (p) and the values at the end of the treatment (e) for 1-NA angle.

Facial Type	Initial average	Proposed average	Average after treatment	Difference e-p	p-value	Test
Horizontal	6.78	4.60	6.02	1.42	0.21%	Student *t* test
Vertical	6.82	5.51	5.07	-0.44	57.99%	Student *t* test
Balanced	5.97	4.19	5.31	1.12	< 0.01%	Signs of posts

difference between gender, since both presented measurements statistically similar to those proposed by the analyses of Steiner[25,26,27] and Pinzan.[20] The equivalence observed in this study is due, possibly, to the underestimation in the horizontals and the overestimation in the verticals, i.e., they have not suffered the influence of Steiner's[25,26,27] maxim "the more it has, the more it will have and vice versa" (Table 6)

Predictability of the 1-NA measurement

The value of the 1-NA measurement was underestimated at the time of the Steiner's individualization analysis on all three groups. As one can see in Table 7, the accuracy rate of the estimates was reduced. Values tend to overestimate the protrusion of the upper incisor in the horizontal and vertical groups, a result that agrees with those obtained by Silva[24] and the Craniofacial Growth Atlas,[15] confirming what would be a characteristic and/or preference of Brazilians for more protruding incisors. These results are also found in the limits of the average values found by Harris et al.[10]

The values obtained at the end of the treatment differ from the estimates in the horizontal and balanced groups, differently from the vertical group, where the values are closer to those projected by Steiner.[25] This result was also found in the work conducted by Farret[7] in his Class I sample, where values were very similar for all groups (Fig 4). The average values for 1-NA, at the end of the treatment differ from the "ideal" value advocated by Steiner[25] in all facial types, differing also from the corresponding acceptable compromise for the ANB angle of 40, which would correspond to the 1-NA measurement equal to 2 mm since, in the present study, this measurement has the approximate value of 5 to 6 mm. In the study carried out by Kowalski,[13,14] they presented 1-NA equal to the value advocated by Steiner[25] (Table 8), even though they differed from the proposed ideal value.

The results of the analysis of variance (ANOVA) comparing the three studied groups as to the interference of the gender for the 1-NA measurement did not show a direct effect. In the horizontal group, female individuals present a significant difference between the proposed and the final measurements, which does not happen to males. In the vertical type, there was no difference, and in the balanced there was only a more accentuated behavior for males in relation to the difference between the proposed and the final measurement.

In the balanced patient group, the error margin for less was greater, in relation to the other groups, or, in other words, the predicted retraction of the upper incisors was greater than the obtained and than what was thought necessary in the proposal. This rigid vision of treatment can, determine unnecessary extractions causing straighter profiles, inconsistent with Brazilian esthetic standards.

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CONCLUSION

Based on the results obtained and discussed, we were able to conclude that:

» There was no influence of gender on the behavior of measurements ANB, 1-NB, P-NB and 1-NA.

» The propositions made after Steiner's analysis elaboration differed significantly from the results obtained with the orthodontic treatment, with the exception of the variable P-NB.

» The proposed values for ANB were statistically different from the values obtained at the end of the treatment, with the exception of the balanced group, considering that the proposed value for the horizontal group was underestimated in relation to the other groups.

» In relation to the 1-NB measurement, the proposed values during Steiner's analysis elaboration for the balanced and vertical groups were not reached.

» For the 1-NA measurement, the obtained values at the end of treatment differ from the estimates on all three analyzed groups. In the vertical group the final value was the one that came closer to the proposed one.

» The limitations of the measurement estimates for ANB, 1-NB, P-NB and 1-NA do not invalidate its use as long as they are used with restrictions.

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Angle Class I malocclusion with anterior open bite treated with extraction of permanent teeth

Matheus Melo Pithon[1]

This clinical case reports the orthodontic treatment of a Class I malocclusion with anterior open bite and bimaxillary dentoalveolar protrusion in a 28-year-old female patient. The treatment of choice was to perform tooth extractions followed by retraction of the anterior teeth, with consequent closure of the anterior open bite and better accommodation of the teeth on their bony bases. This case was presented to the Brazilian Board of Orthodontics and Facial Orthopedics (BBO), representing the Category 2 — i.e., an Angle Class I malocclusion, with anterior open bite, treated with extraction of permanent teeth —, as part of the requisites to become a BBO diplomate.

Keywords: Open bite. Tooth extraction. Corrective orthodontics.

HISTORY AND ETIOLOGY

The patient, a woman aged 28 years and 8 months presented for the initial consultation in a good state of general health, with the chief complaint that her "*front teeth did not touch, and they were unable to cut anything*". Her dental history contained no significant records, only some previously performed restorations without endodontic involvement, and moderate bone loss in the region of the maxillary and mandibular molars. The patient reported that she had the habit of biting her nails (onicophagy) when she was nervous. In addition, reported that she did not remember when her mandibular right first molar was extracted (tooth #46). As regards functional activities, she presented alterations in the tongue position during swallowing movements. She had adequate oral hygiene, despite of a high frequency of caries.

DIAGNOSIS

Regarding the facial aspect, the patient presented a convex profile (UL-S line = +4 mm, LL-S line = +6 mm) with passive lip sealing, diminished nasolabial angle, increased lower facial third, lack of space to accommodate teeth #12 and #22, and absence of noticeable asymmetries (Fig 1).

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* Clinical case, category 2, accepted by the Brazilian Board of Orthodontics and Dentofacial Orthopedics, BBO.

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» The author reports no commercial, proprietary or financial interest in the products or companies described in this article.

» The patient displayed in this article previously approved the use of her facial and intraoral photographs.

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Figure 1 - Facial and intraoral initial photographs.

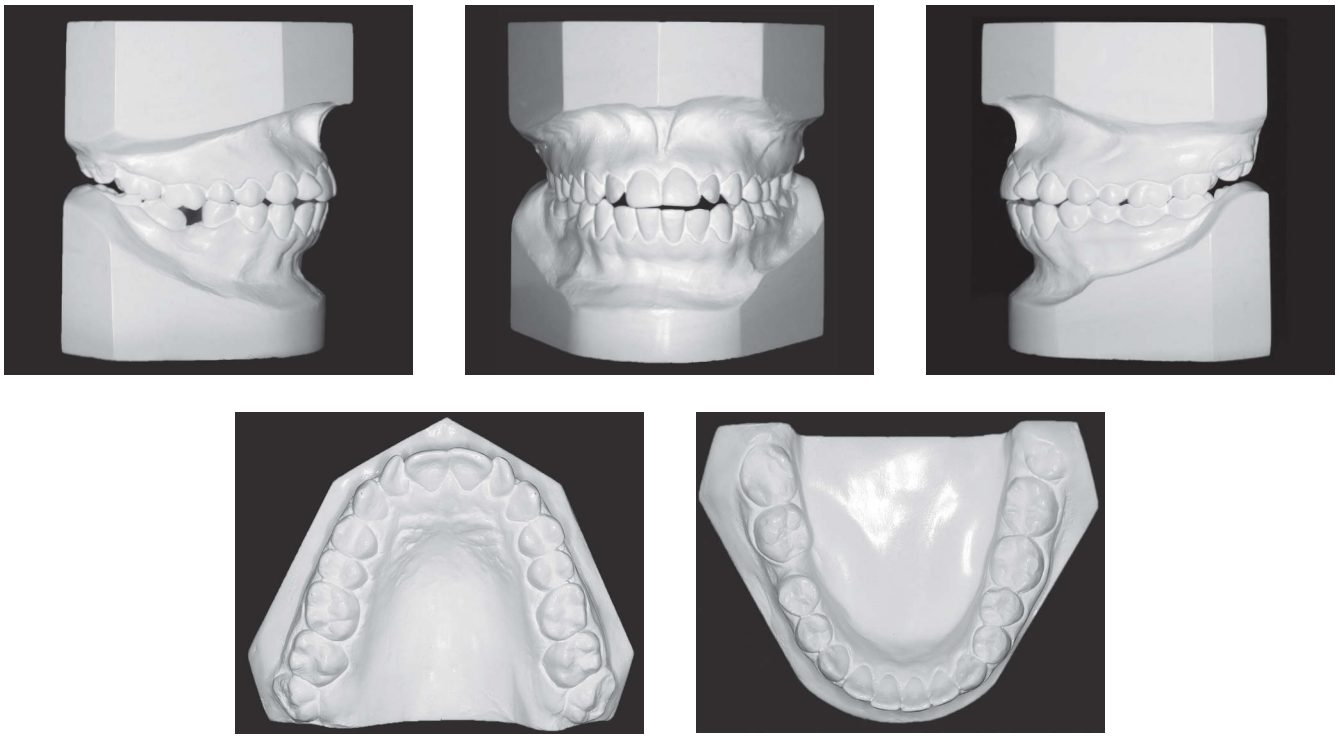


Figure 2 - Initial casts.

The occlusal analysis revealed an Angle Class I malocclusion; excessive space in mandibular arch, with a 3.6 mm arch length excess, mandibular tooth size discrepancy with excess of 2.9 mm in the posterior region and 1.1 mm in the anterior region; coincident maxillary midline, and mandibular midline with a 0.5 mm deviation to the right; 0.5 mm overjet and anterior open bite of 2 mm in the region of the lateral incisors and left canine, and 1 mm in the region of the central incisors and mandibular right molars, which were mesially tipped (Figs 1 and 2).

With regard to the asymmetries, in the anteroposterior direction, tooth #26 was 1 mm towards the mesial direction in relation to the #16; and tooth #23, 0.5 mm mesial to the #13; tooth #33, 3 mm mesial to the #43. In the transverse direction, tooth #26 was 1 mm buccal in relation to the #16; tooth #23, 0.5 mm buccal to the #13; and tooth #43, 1 mm buccal to the #33. Both dental arches presented a parabolic shape with excess of space in the mandibular arch — as a result of the premature extraction of tooth #46 —, and lack of space in the maxillary arch to accommodate teeth #12 and #22 (Fig 2).

In the panoramic radiograph, it was verified the inclination of mandibular right molars (teeth #47 and #48) in the mesial direction, due to tooth #46 extraction; moderate bone loss in the maxillary and mandibular molars region; radiopaque images in the premolars and molars crowns, compatible with the image of metal restorations; and presence of all third molars (Fig 3).

The periapical radiographs revealed root resorption in the maxillary incisors, with greater loss in teeth #21 and #22. Loss of alveolar bone crest could also be seen in the anterior region (Fig 3).

As regards the skeletal characteristics: There was a skeletal Class II (ANB = 7°), with the maxilla protruded in relation to the cranial base, and the mandible well positioned (SNA = 90° and SNB = 83°); a balanced growth pattern, with a tendency towards vertical facial growth (SN-GoGn = 39°) (Fig 4 and Table 1).

The cephalometric analysis (Fig 4 and Table 1) also informed about the projection and buccal inclination of the maxillary and mandibular incisors (1.NA = 25°, 1-NA = 6 mm, 1.NB = 49° and 1-NB = 15 mm).

With regard to the functional aspect, the patient presented no canine guides, and anterior guide with various posterior premature occlusal contacts.

TREATMENT OBJECTIVES

The treatment goals were: Reduction of the bimaxillary protrusion, with decrease of the nasolabial angle; closure of the anterior open bite; teeth alignment and leveling, achieving good axial inclinations and closure of all spaces; correction of mesiodistal size of the teeth, eliminating the tooth size discrepancy; symmetry of maxillary and mandibular dental arches; in addition to achieving normal overbite and overjet with canines in Class I relationship.

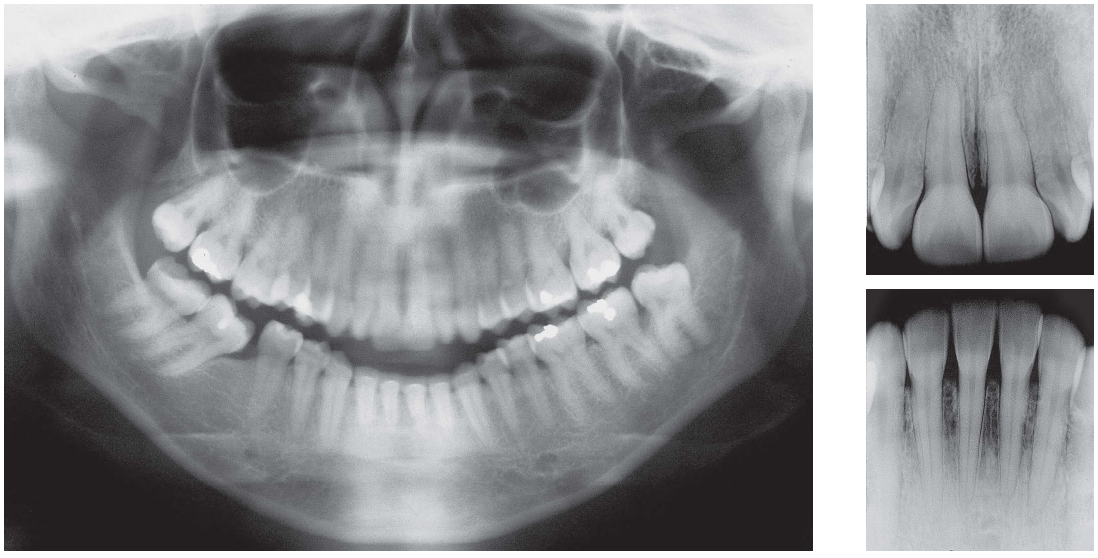


Figure 3 - Initial panoramic and periapical radiographs.

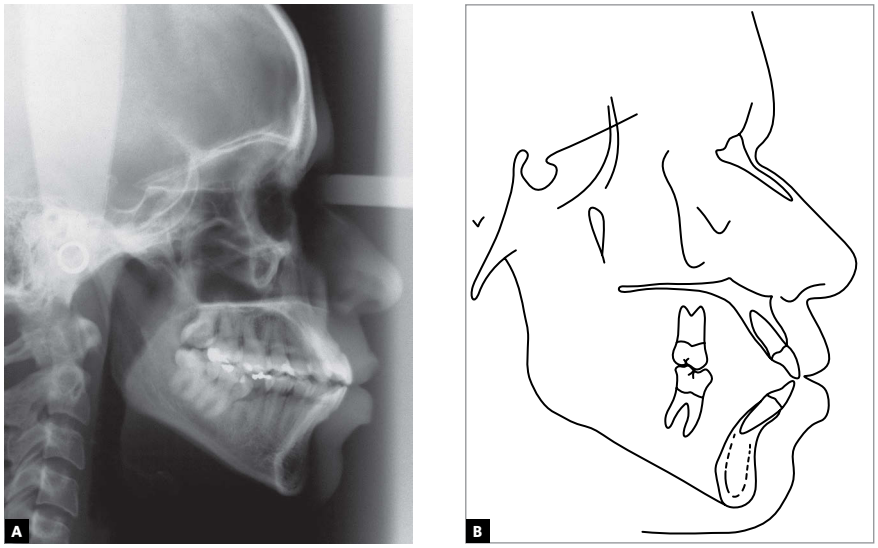


Figure 4 - Initial cephalometric profile radiograph (A) and cephalometric tracing (B).

TREATMENT PLAN

The proposed treatment plan was the extraction of maxillary first premolars (#14 and #24) and one mandibular first premolar, tooth #34. The extraction of tooth #44 was not proposed because the patient had suffered early loss of tooth #46. As anchorage resources, it was installed a mandibular lingual arch and a Nance plate in the maxillary arch (Nance button with increased dimensions of the acrylic part). As an alternative treatment plan, the placement of orthodontic mini-implants was proposed to the patient, instead of using the Nance plate and the lingual arch. Initially, the idea was to partially install the appliance in the maxillary arch, without bonding teeth #12 and #22 — which showed lack of space for alignment —; insert the Nance plate and extract teeth #14 and #24. After partial retraction of teeth #13 and #23 in a 0.020-in passive archwire, teeth #12 and #22 would be included followed by alignment and leveling with 0.012-in, 0.014-in, 0.016-in, 0.018-in and 0.020-in archwires. Retraction of canines would be concluded in the 0.020-in archwire, followed by a 0.019 x 0.026-in archwire with teardrop loops in the distal region of the lateral incisors, for incisors retraction.

In the mandibular arch, the treatment plan was to mount the orthodontic appliance and then request the extraction of tooth #34, beginning the alignment and leveling with 0.012-in, 0.014-in, 0.016-in and 0.020-in archwires. After the uprighting of tooth #47, a lingual arch supported on teeth #47 and #36 would be placed, as an anchorage resource. With the 0.020-in archwire in place, retraction of teeth #33 and #45 would be performed, followed by the retraction of teeth #44 and #43. After the mandibular canines have been retracted, a 0.019 x 0.026-in archwire with teardrop loop in the distal region of the lower lateral incisors would be installed for the retraction of the mandibular anterior teeth.

After the retraction of the maxillary and mandibular anterior teeth, intercuspation elastics would be used. When the treatment has been concluded with the correction of malocclusion, the orthodontic appliance would be removed, followed by the insertion of a wraparound retainer in the maxillary dental arch and a bonded lingual retainer in the mandibular arch.

TREATMENT PROGRESS

To treat this malocclusion an Edgewise standard (0.022 x 0.028-in) fixed appliance was used. Initially, it was performed the banding of teeth #16, #17, #26, #27, #36, #37, #47 and #48; placement of single brackets on teeth #16, #26, #36 and #47, and tubes on teeth #17, #27, #37 and #48. In the same session a transfer impression was performed for confection of the maxillary Nance plate supported on teeth #16 and #26. Then brackets were bonded on the other teeth, with the exception of #14, #24, #34, #12 and #22. Extraction of teeth #14, #24 and #34 was requested.

Treatment in the upper arch started with a 0.020-in passive archwire, and initiation of partial retraction of teeth #13 and #23 with chain elastics. During this stage, the posterior teeth were kept tied together, to increase posterior anchorage. After obtaining sufficient space to accommodate teeth #12 and #22, brackets were bonded on them, and started the

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alignment and leveling with 0.012-in, 0.014-in, 0.016-in, 0.018-in and 0.020-in coordinated and symmetrical archwires with first and second order bends. With the 0.020-in archwire the retraction of teeth #13 and #23 was resumed. Then a 0.019 x 0.026-in archwire with teardrop loops was placed in the distal region of the lateral incisors. During retraction, the anterior teeth were kept tied together to prevent the opening of spaces. An accentuated curve of Spee was incorporated into the archwire to control the overbite. After the conclusion of this stage, the Nance plate was removed and a 0.019 x 0.026-in stainless steel archwire with an ideal shape and torque was fabricated, and coordinated for conclusion of the treatment.

In the mandibular arch, treatment began with the fabrication of 0.012-in, 0.014-in, 0.016-in and 0.020-in continuous archwires with first and second order bends for alignment and leveling. After uprighting of tooth #47, a transfer impression was performed for fabrication of the lingual arch supported on teeth #36 and #47. Then, retraction of teeth #33 and #45 began with chain elastics, with the posterior and anterior teeth tied together to form two blocks, a posterior and a anterior. For retraction of anterior teeth a 0.019 x 0.026-in archwire with teardrop loops was placed in the distal region of the lateral incisors. During retraction, the anterior teeth were tied together to prevent the opening of spaces. A reverse curve of Spee was incorporated into the archwire to control the overbite. After retraction, the lingual arch was removed and a 0.019 x 0.026-in steel archwire was fabricated with an ideal shape and torque,



Figure 5 - Facial and intraoral final photographs.

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and coordinated for conclusion of the treatment. Intermaxillary elastics for posterior (1/8-in heavy) and anterior (5/16-in medium) intercuspation were used.

After removal of the orthodontic appliance, a wrap-around retainer was placed in the maxillary arch and a bonded lingual retainer in the mandibular arch.

RESULTS OBTAINED

When evaluating the patient's face and her occlusion on the post-orthodontic treatment records, one may verify that all the treatment goals proposed were attained (Figs 5 to 9). With regard to the facial aspect there was improvement in the facial profile, with correction of bimaxillary protrusion, maintenance of passive lip sealing, increase in the nasolabial angle, in addition to obtaining a good smile line with better dental inclinations and good disposition of the teeth in the dental arches (Fig 5).

Skeletally, there was an improvement in the maxillomandibular relationship with a reduction of 1° in ANB angle, due to the better position of the teeth on their bony bases. The vertical growth pattern remained unaltered, without worsening in the vertical component of the patient's face (Fig 8).

As regards the dental aspect, there was correction of the canine relationship on the right side, which presented in Class II; maintenance of the molar relationship on the left side in Class I; achievement of a Class II molar relationship on the right side; and retraction with discrete extrusion of the maxillary incisors. Maxillary and mandibular molars underwent discrete mesial tipping and did not extrude; the mandibular incisors were retracted and intruded. There was correction of crowding in the maxillary arch and closure of spaces in the mandibular arch; space was obtained in the arch to accommodate teeth #12 and #22; uprighting of the mandibular premolars and molars, and readjustment of the mesiodistal diameter of the mandibular anterior and posterior teeth, eliminating the tooth size discrepancy. These changes promoted correction of the contact points and the overjet; also closure of anterior open bite, obtaining a correct overbite; in addition to coordinated and symmetrical dental arches, and midlines coincident with the facial midline (Figs 5 and 6).

With regard to the functional aspect, simultaneous bilateral contacts in harmony with the centric relationship and disocclusion of the posterior teeth by the anterior teeth in mandibular excursive movements were obtained.

With respect to the roots situation, a considerable worsening of root resorption occurred, without compromising the stability of the teeth (Fig 7).

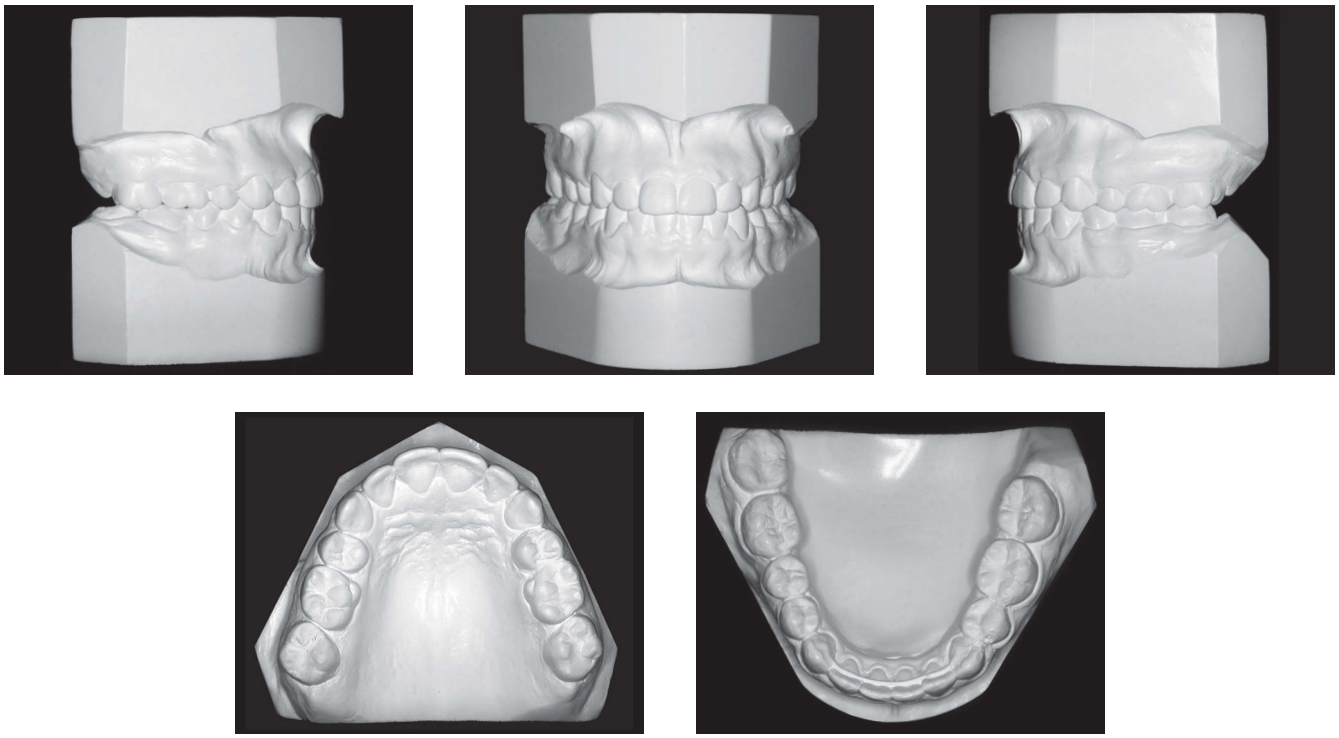


Figure 6 - Final casts.



Figure 7 - Panoramic and periapical final radiographs.

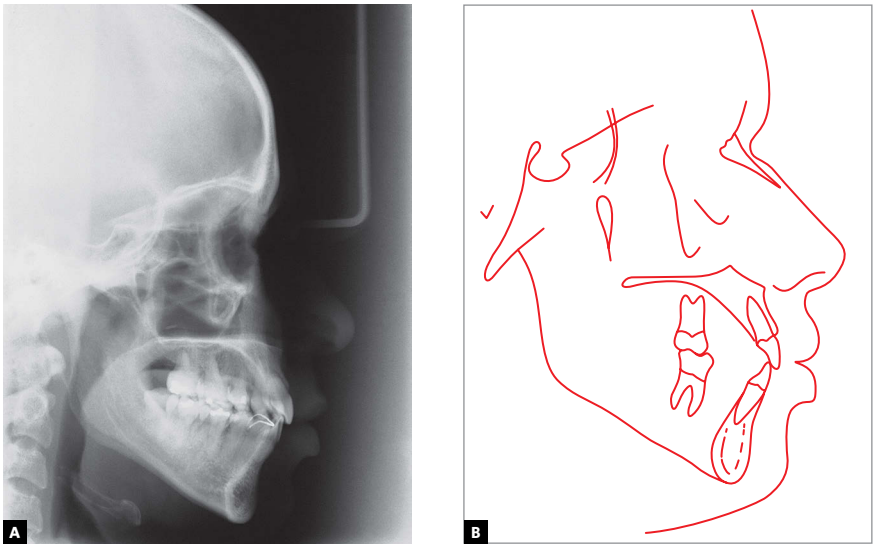


Figure 8 - Final cephalometric profile radiograph (A) and cephalometric tracing (B).

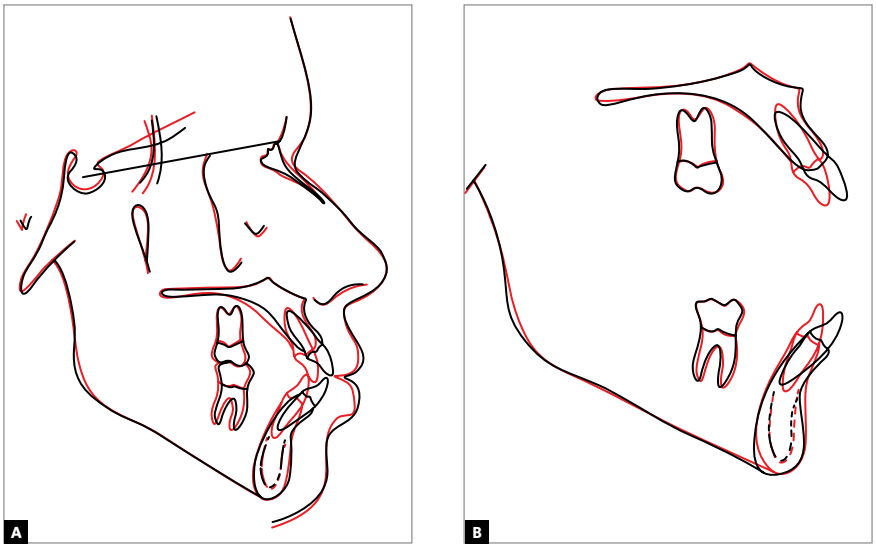


Figure 9 - Total (A) and partial (B) superimpositions of initial (black) and final (red) cephalometric tracings.

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Table 1 - Summary of cephalometric measures.

	MEASURES		Normal	A	B	Diff. A/B
Skeletal pattern	SNA	(Steiner)	82°	90°	88°	2
	SNB	(Steiner)	80°	83°	82°	1
	ANB	(Steiner)	2°	7°	6°	1
	Convexity angle	(Downs)	0°	16°	13°	3
	Y axis	(Downs)	59°	55°	56°	1
	Facial angle	(Downs)	87°	95°	94°	1
	SN-GoGn	(Steiner)	32°	39°	39°	0
	FMA	(Tweed)	25°	27°	28°	1
Dental pattern	IMPA	(Tweed)	90°	108°	89°	19
	$\underline{1}$.NA (degrees)	(Steiner)	22°	25°	15°	10
	$\underline{1}$-NA (mm)	(Steiner)	4 mm	6 mm	3 mm	3
	$\underline{\overline{1}}$.NB (degrees)	(Steiner)	25°	49°	30°	19
	$\underline{\overline{1}}$-NB (mm)	(Steiner)	4 mm	15 mm	8 mm	7
	$\frac{1}{1}$ -Interincisal angle	(Downs)	130°	98°	128°	30
	$\underline{\overline{1}}$-APo (mm)	(Ricketts)	1 mm	0 mm	0 mm	0
Profile	Upper lip – S line	(Steiner)	0 mm	4 mm	2.5 mm	1.5
	Lower lip – S line	(Steiner)	0 mm	6 mm	3.5 mm	2.5

FINAL CONSIDERATIONS

Orthodontic treatments with tooth extraction have been the reason for controversial debates and opinions.[1,2] The main discussions are with regard to post-treatment stability, the impact of extractions on facial esthetics and the deepening of the profile.[2]

At present, it is known that the most important factor for reaching post-orthodontic treatment stability, both in cases with and without tooth extractions, is the quality of occlusion on treatment conclusion.[3] Therefore, one should seek an excellent occlusion, with simultaneous bilateral contacts in harmony with the centric relation and immediate disocclusion of the posterior teeth by the anterior teeth in excursive mandibular movements.[4]

There is consensus that the most significant alterations that occur in the facial profile with orthodontic treatment are in the labial region after the extraction of the first premolars, followed by the retraction of the incisors. Nevertheless, various factors must be considered before making the decision to perform extractions. These factors are the facial profile esthetics, size of the nose, position of the mandibular incisors, facial typology, state of the gingival tissues, amount of crowding, treatment biomechanics, predicted facial growth and type of malocclusion.[5]

In this clinical case, the option was taken for treatment with extractions, because the patient presented very projected incisors that interfered in facial esthetics. The results derived from this chosen treatment were shown to be satisfactory, since the incisors became well positioned on their bony bases, and a good relationship between the dental arches was achieved without the occurrence of profile deepening, which would have been a disaster in this patient, due to her direct ancestry from black ethnicity.

Based on the records obtained at the end of orthodontic treatment, it can be verified that all the proposed objectives were attained: Class I relationship was obtained for the canines, in addition to reduction in bimaxillary protrusion, correction of overjet and open bite, and of the individual tooth malposition.

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Vertical control in the Class III compensatory treatment

Márcio Costa Sobral[1], Fernando A. L. Habib[2], Ana Carla de Souza Nascimento[3]

Introduction: Compensatory orthodontic treatment, or simply orthodontic camouflage, consists in an important alternative to orthognathic surgery in the resolution of skeletal discrepancies in adult patients. It is important to point that, to be successfully performed, diagnosis must be detailed, to evaluate, specifically, dental and facial features, as well as the limitations imposed by the magnitude of the discrepancy. The main complaint, patient's treatment expectation, periodontal limits, facial pattern and vertical control are some of the items to be explored in the determination of the viability of a compensatory treatment. Hyperdivergent patients who carry a Class III skeletal discrepancy, associated with a vertical facial pattern, with the presence or tendency to anterior open bite, deserve special attention. In these cases, an efficient strategy of vertical control must be planned and executed.

Objective: The present article aims at illustrating the evolution of efficient alternatives of vertical control in hiperdivergent patients, from the use, in the recent past, of extra-oral appliances on the lower dental arch (J-hook), until nowadays, with the advent of skeletal anchorage. But for patients with a more balanced facial pattern, the conventional mechanics with Class III intermaxillary elastics, associated to an accentuated curve of Spee in the upper arch and a reverse Curve of Spee in the lower arch, and vertical elastics in the anterior region, continues to be an excellent alternative, if there is extreme collaboration in using the elastics.

Keywords: Orthodontics. Class III malocclusion. Camouflage.

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» Patients displayed in this article previously approved the use of their facial and intraoral photographs.

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INTRODUCTION

The universe of eventual patients liable to orthodontic treatment can be divided into two large groups: With or without skeletal discrepancies. The latter, in turn, is subdivided into the presence or absence of facial growth potential, a relevant fact for the elaboration of the treatment plan, as well as to the prognosis estimate.

The interceptive treatment of important skeletal discrepancies on young patients with growth potential, together with corrective orthodontic procedures, in a subsequent step, can, in theory, redirect facial growth. Such an intervention can minimize and even correct those discrepancies, promoting good occlusion, balance between the jaws, and adequate facial esthetics.

On the other hand, for those who have already finished the outbreak of puberal growth, there are only two alternatives: Compensatory orthodontic treatment, also known as orthodontic camouflage, or orthodontic treatment associated to orthognathic surgery. The decision on what to be performed must be made together with the patient, taking into account the following aspects: Main complaint and yearnings about the treatment results, severity degree of maxillary-mandibular discrepancy, periodontal limits for orthodontic movement, clinical condition of present teeth and the impossibility of growth modification.

ORTHODONTIC CAMOUFLAGE

Orthodontic camouflage consists on the displacement of teeth in relation to the supporting bone, to compensate the discrepancy between the jaws. It can be accomplished by dental inclination. Depending on the desired level of compensation and the magnitude of orthodontic movement, some times extractions are needed.

As suggested by Proffit et al,[1] there is a limit for incisor orthodontic movement, that is, in some cases, orthodontic treatment has to be associated with the movement of the basal bones by facial orthopedics or orthognathic surgery. However, dental movement can camouflage a broad variety of skeletal discrepancies, without deleterious effects on the periodontal structures. Nevertheless, correct diagnosis and a realistic treatment plan are necessary to avoid undesirable sequelae.[5]

Orthodontic camouflage is well fit for patients that carry small skeletal Class III, with no growth potential, with a relative fine facial balance and without severe crowding. Almost always, the compensatory orthodontic treatment is followed by the patient fear of facing surgical procedure, and by his relative satisfaction with his facial aspect, generating a small demand for great changes on this feature.

In relation to Class III, when the skeletal problem is small, the facial aspect is improved after camouflage; however, in moderate and severe cases, orthodontic treatment produces considerable worsening on facial esthetics, because the slightest retraction of lower incisors increases the chin prominence.[1]

When asymmetry is added to the skeletal discrepancy, it is imperative to pay attention in the patients' expectations concerning treatment, because orthodontic camouflage is not going to correct it. Yet, facial asymmetry may not cause great impact on esthetics or, even if it is noticed, the patient may reject surgical treatment.

CLASS III CAMOUFLAGE – CLINICAL AND MECHANICAL ASPECTS

Early intervention on skeletal Class III discrepancies, in the mixed dentition and even in the deciduous dentition, is more and more attracting orthodontist's attention. However, the skeletal Class III pattern worsens with age, that is, the deformity, apparently corrected during childhood, presents relapse during adolescence. This brings great difficulties to treatment success of the problem.[2,7] Nevertheless, patients with light or moderate skeletal Class III malocclusion and with acceptable facial esthetics can benefit from a compensatory orthodontic treatment.[4]

The strategy to camouflage a Class III malocclusion usually involves buccal inclination of upper incisors and retroinclination of lower incisors to improve dental occlusion, but it does not correct the skeletal problem or modify facial profile in a meaningful way.[5,6]

It is important to notice the cases in which the facial type of the patient is characterized as vertical and/or with a hiperdivergent tendency, or with anterior open bite. In those cases it is necessary to associate vertical control strategies during tooth movement, with the goal of avoiding undesirable opening of the mandibular plane, which would meaningfully worsen the vertical relation on the anterior region, hampering or even stopping the achievement of a satisfactory

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occlusion at the end of the treatment. One of the effective ways to accomplish vertical control remounts to the mechanical principles of Tweed-Merrifield technique, that nowadays, associated with skeletal anchorage devices, are extremely predictable and easily used by patients.[12]

Orthodontic camouflage treatment must be indicated for young patients, only if, before starting treatment, cephalometry shows that residual growth is not going to aggravate the deformity after treatment.[6] Besides, most of the patients that have a serious Class III skeletal deformity are liable to orthognathic surgery as the only option to obtain both normal occlusion and a pleasant profile, concerning esthetics.[2]

The goal of the present article is to illustrate the evolution of efficient strategies of vertical control in hyperdivergent patients, since the use, in the recent past, of extraoral devices on the lower arch (J-hook), until nowadays, with the advent of skeletal anchorage. But, for patients with a more balanced facial pattern, the conventional mechanics with intermaxillary elastics in Class III direction associated to an accentuated curve of Spee on the upper arch, and a reverse Curve of Spee in the lower arch, and vertical elastics in the anterior region, continues to be an excellent alternative, if there is extreme collaboration on the use of the prescribed mechanics.

PATIENTS WITH A BALANCED FACIAL PATTERN

Case 1 – Class III with anterior open bite and posterior bilateral crossbite, treated with extractions (#38, #48)

» **Vertical control**: Accentuated curve of Spee on the upper arch, reverse on lower arch and vertical elastics on anterior region.

History and etiology

The patient, 27 years old, presented for the initial exam in a good general state of health. His main complaint reported functional problems related to mastication. Facial esthetics did not seem to be a concern (Fig 1). With more detailed examination of the occlusion, a disharmony between the maxilla and the mandible, in the anteroposterior direction was noticed. There was no reference to Class III in his family medical history.

Diagnosis

Regarding facial features, he presented a mesocephalic facial type, with a straight profile, proportional and harmonious facial third, lip competence at rest, and absence of evident asymmetries. The smile was unbalanced, with exposure of lower incisors (Fig 1).

In the dental aspect, he presented an Angle Class III malocclusion, with anterior open bite (2 mm), posterior bilateral crossbite, edge to edge relationship of incisors. Also, a 2 mm anteroinferior crowding was noticed, with rotations of central incisors and canines with mesial angulation; coincident midlines (Fig 1); good oral hygiene and healthy periodontium.

The panoramic radiograph analysis did not show any significant alteration that could contraindicate the performance of orthodontic treatment (Fig 2) Cephalometric evaluation indicated important skeletal disharmony, with ANB angle equal to -1° (SNA=86° and SNB=87°), with good mandibular growth in the vertical direction (SN-GoGn=32°), highlighting the balanced facial aspect. Upper and lower incisors were slightly tipped buccally (these observations can be better evaluated on Figure 3 and Table 1).

Treatment objectives and alternatives

It is possible to present, as the main objectives for treatment of the reported patient, by its order of importance: Expansion of the upper arch, eliminating premature contacts and correcting the posterior crossbite; by extracting lower third molars, to allow for the distalization of lower teeth, with the objective of correcting Class III malocclusion and establish adequate intercuspation. Since he showed a slight anterior open bite, precautions with vertical control were set during the distalization of the lower teeth.

The possibility of surgical treatment was not considered, because of the reduced magnitude of skeletal discrepancy, as well as because of the absence of adverse features on facial esthetics that could justify such an approach.

Treatment

Despite skeletal discrepancy (ANB = -1°), the case presented treatment feasibility to be just orthodontic. By examining him in detail, it was noticed that the presence of anterior open bite was conditioned to premature contacts on the posterior region, due to the crossbite.

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Figure 1 - Facial and intraoral initial photographs.

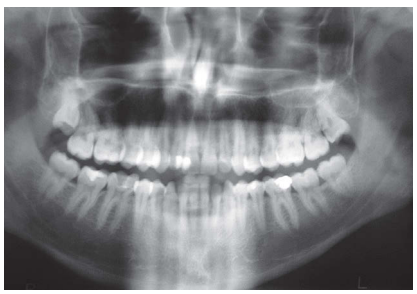


Figure 2 - Initial panoramic radiograph.

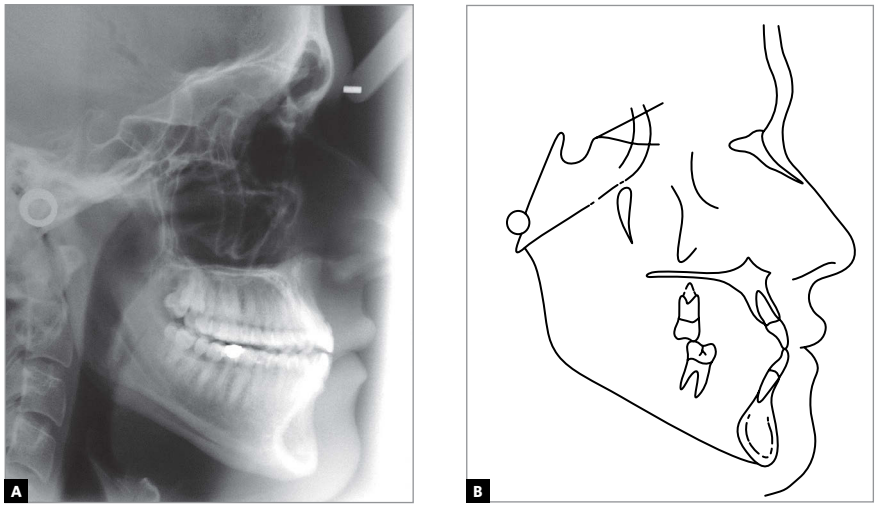


Figure 3 - Initial lateral cephalometric radiograph (**A**) and tracing (**B**).

So, the first treatment step would be to expand the upper arch, to eliminate transverse discrepancy, in order to obtain a more adequate evaluation on the real magnitude of the Class III, because it was believed that, in part, the latter was due to functional accommodation of the mandible.

The treatment itself was started with slow expansion of the upper arch (1/4 turn in alternate days, during 30 days) with a Hyrax type expander, with the objective to improving arch form, making it compatible, in the transverse dimension, with the lower arch. Three months after the correction of the posterior crossbite, the Hyrax expander was removed and then standard Edgewise 0.022 x 0.028-in slot metal brackets, with no torque or angulations, were installed.

In the lower arch, extractions of #38 and #48 were requested, with posterior appliance placement, with the exception of canines and incisors — because if they were included, it would cause undesirable projection of these teeth, due to the presence of crowding.

Once alignment and levelling of upper and lower arches (with exception of teeth #31, #32, #33, #41, #42, #43), was concluded, the improvement of coordination was beginning to be noticed on the anterior region, with the reduction of open bite (Fig 5). At this moment, 0.018 x 0.025-in steel arches were placed on both arches.

Class III mechanics (150 g/side) was started, attached to teeth #17, #27 and on long sliding jigs on the lower arch, extending from the tubes of teeth #37 and #47 to the mesial of lower canines (Figs 5 and 6). With that, the objective of this step was to use all the anchorage of the upper arch to distalize, tooth by tooth, the lower arch, by the means of light forces, in order to minimize collateral effects — such as the counterclockwise rotation of the upper occlusal plane. Thus the treatment was conducted until the correction of molar relation and the attainment of space on anteroinferior region. Then the canines and incisors were included, performing once more the alignment and levelling of the lower arch.

» **Vertical control:** At the moment the arches were found stable with rectangular 0.018 x 0.025-in wires, a specific intermaxillary Class III mechanics was started, with the objective of promoting refinement on the intermaxillary correction obtained before with the sliding jigs. Now, with heavier forces (150 g/ side), and the curve of Spee accentuated on the upper arch, reverse on the lower arch, and vertical elastics in the anterior region (150 g), the ideal conditions for adequate finishing were established (Fig 4). At this moment, the only limitation was restricted to the patient's agreement on using the elastics. The accentuated and reverse curves of Spee, respectively on the upper and lower arches, along with anterior vertical elastics, had the function of promoting efficient vertical control, with the closing of the anterior open bite due to the rotation of the upper occlusal plane with a clockwise direction and of the lower occlusal plane with a counterclockwise direction, which happened as expected (Fig 5).

The option for this kind of mechanics was because of the favorable dental and facial features presented by the patient. That would not be a good Indication for patients with excessive vertical pattern, once that, if the patient does not collaborate with the use of elastics, the effects on the occlusion may be disastrous and of harder resolution. Then, upper and lower 0.019 x 0.026-in stainless steel arches, were made with individualized bends, for proper finishing. The retention on the upper arch was accomplished with a wraparound and, on the lower one, with an intercanine fixed retainer (0,032-in).

Analysis of results

The main objectives of the treatment were accomplished, establishing an adequate dental relationship, with direct repercussion on the esthetics of the smile (Fig 7). As expected, no alteration on facial esthetics was not found. The patient was extremely cooperative, concerning the use of the proposed mechanics. With the dental alterations, the ANB angle was maintained, and there was a buccal inclination of upper incisors and retroinclination of lower ones, as well as efficient vertical control, with maintenance of the mandibular plane (Figs 8, 9, 10 and Table 1).

At the end of treatment, it was possible to observe the achievement of a Class I occlusion on canines and molars, and correction of anterior open bite, as well as adequate alignment and levelling (Fig 7).

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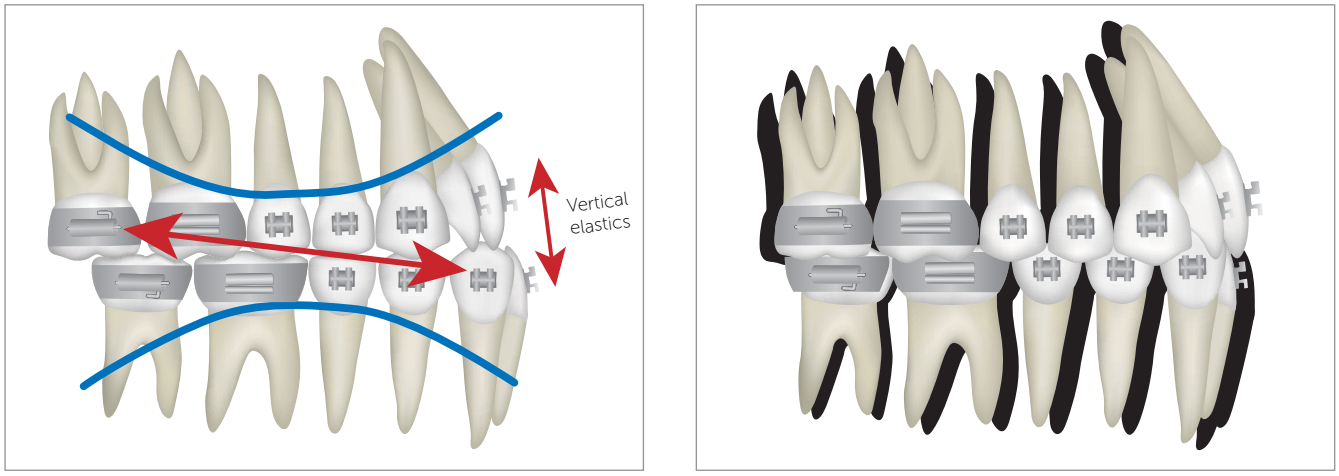


Figure 4 - Illustration of Class III mechanics use of intermaxillary elastics, reverse curve of Spee on the lower arch and accentuated Curve of Spee on the upper arch, associated to vertical elastics in the anterior region.

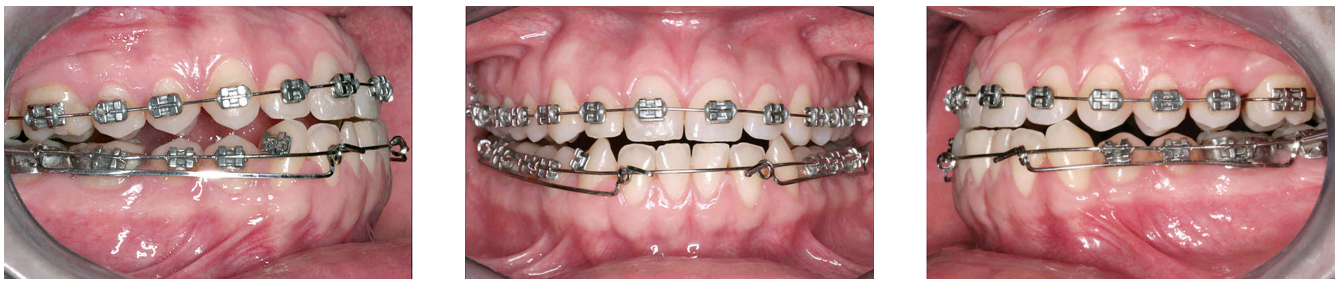


Figure 5 - Initial step of treatment. Class III mechanics with long sliding jigs (lower arch).

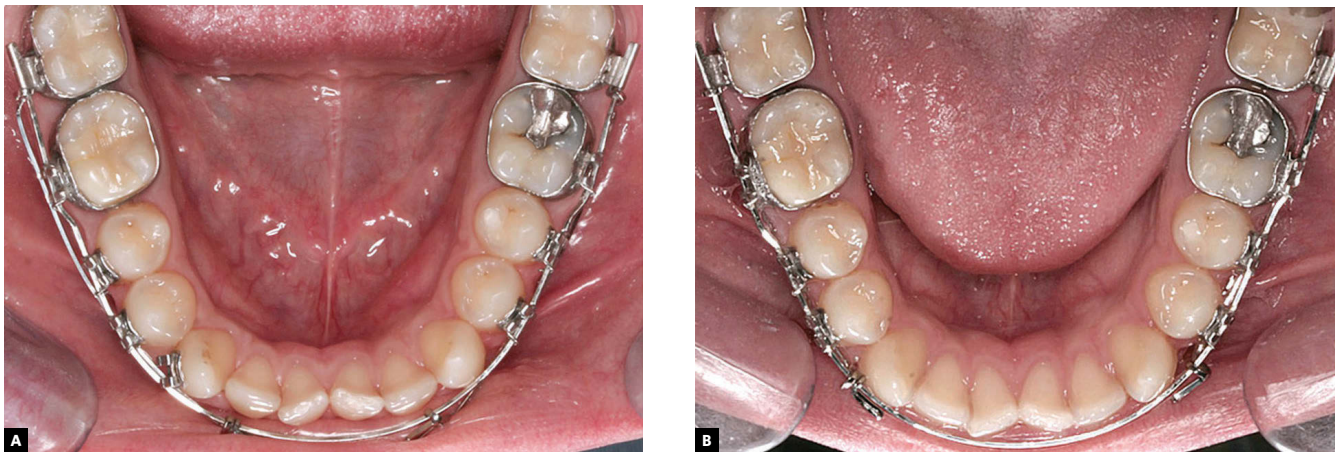


Figure 6 - **A**) Beginning of Class III mechanics. **B**) After 40 days, spaces between the upper teeth can be noticed.

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Figure 7 - Final facial and intraoral photographs.

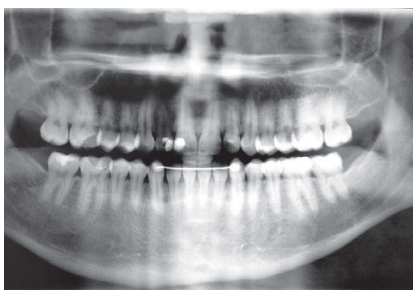
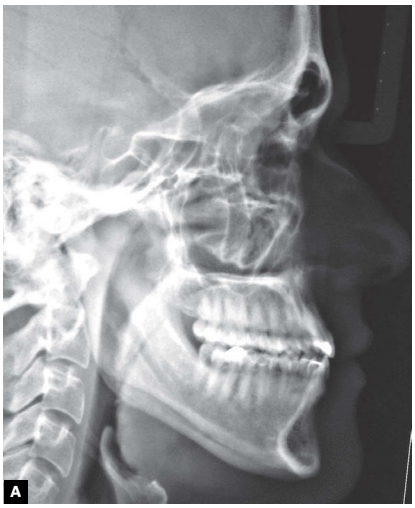


Figure 8 - Final panoramic radiograph.



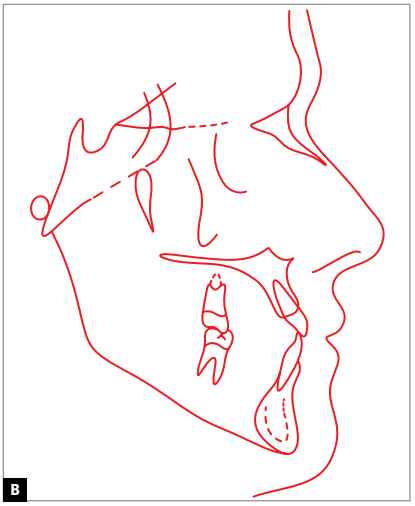


Figure 9 - Final lateral cephalometric radiograph (**A**), and cephalometric tracing (**B**).

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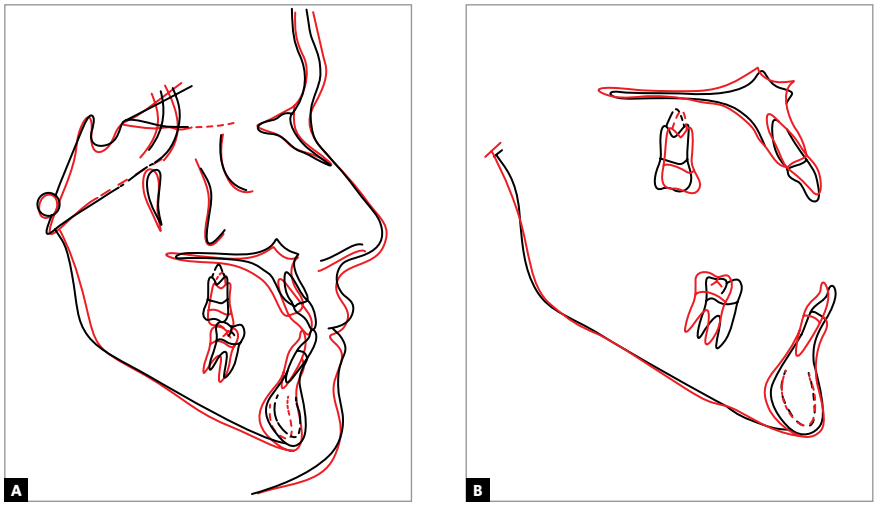


Figure 10 - Total (**A**) and partial (**B**) superimpositions of initial (black) and final (red) cephalometric tracings.

Table 1 - Summary of cephalometric measurements.

	Measures		Normal	A	B	A/B diff.
Skeletal pattern	SNA	(Steiner)	82°	86°	84°	2
	SNB	(Steiner)	80°	87°	85°	2
	ANB	(Steiner)	2°	-1°	-1°	0
	Convexity angle	(Downs)	0°	-5°	-5°	0
	Y axis	(Downs)	59°	58°	58°	0
	Facial angle	(Downs)	87°	86°	86°	0
	SN-GoGn	(Steiner)	32°	32°	33°	1
	FMA	(Tweed)	25°	27°	28°	1
Dental pattern	IMPA	(Tweed)	90°	92°	85°	7
	1.NA (degrees)	(Steiner)	22°	24°	28°	4
	1-NA (mm)	(Steiner)	4 mm	11 mm	9 mm	2
	1.NB (degrees)	(Steiner)	25°	30°	22°	8
	1-NB (mm)	(Steiner)	4 mm	9 mm	6 mm	3
	$\frac{1}{1}$ –Interincisal angle	(Downs)	130°	126°	130°	4
Profile	Upper Lip – S Line	(Steiner)	0 mm	-1 mm	-3 mm	2
	Lower Lip – S Line	(Steiner)	0 mm	-3.5 mm	-3.5 mm	0

PATIENTS WITH ADVERSE VERTICAL FACIAL PATTERN

Case 2 – Class III with anterior open bite and mandibular asymmetry, treated with extractions (#15, #25, #34, #44).

» **Vertical control**: Extraoral forces with high pull headgear (J-hooks).

History and etiology

The patient, 20 years old, presented for initial exam in a good general state of health. Her main complaint was related to the presence of anterior open bite and facial asymmetry, with mandibular deviation to the left side. Facial esthetics seemed to be a concern to the patient, due to the asymmetry caused by laterognathism (Fig 11). With more detailed examination of the occlusion, a real mandibular deviation to the left side was noticed, generated, probably, by asymmetric growth, and not by a purely functional deviation. Although, according to the mother, there was no reference to Class III on her family medical history, the peculiarities involved pointed to a multifactorial etiology.

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Figure 11 - Initial facial and intraoral photographs.

Diagnosis

Regarding facial features, she presented a dolichocephalic facial type, with a convex profile, inferior facial third slightly increased, lip competence, and presence of asymmetry due to mandibular deviation to the left. The lips were protruded, the lower one being slightly on front of the upper one (Fig 11).

In the dental aspect, she presented an Angle Class III malocclusion, with anterior open bite, 1 mm overjet, with buccal tipping of upper and lower incisors, characterizing a dentoalveolar double protrusion. Yet, an atresic upper arch was noticed, with a slight anterosuperior crowding and rotation of teeth #15 and #25. The lower midline was deviated 2,5 mm to the left, but was coincident with the center of the chin, characterizing a skeletal deviation, but not a dental one (Fig 11).

The panoramic radiograph analysis did not show any significative alteration that could contraindicate the performance of orthodontic treatment (Fig 12). Cephalometric evaluation indicated important skeletal disharmony, with ANB = -2° (SNA = 78° and SNB = 80°), with a poor mandible with a vertical growth direction (SN-GoGn = 39°), aggravating the vertical facial aspect. The maxilla and the mandible were slightly retruded in relation to the cranial base (this can be better evaluated on Fig 13 and Table 2).

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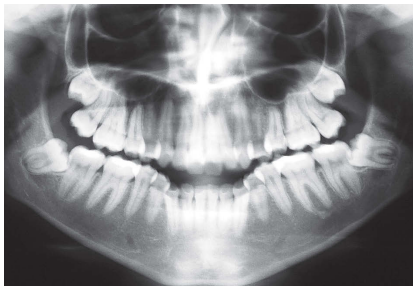


Figure 12 - Initial panoramic radiograph.



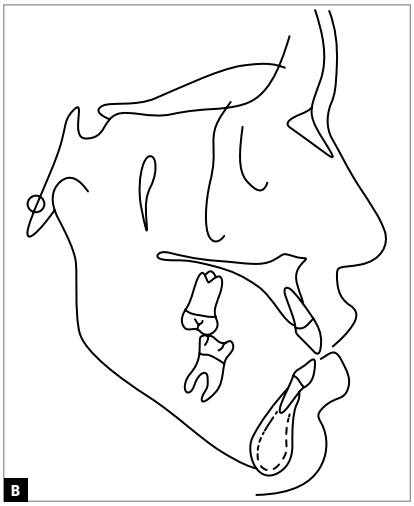


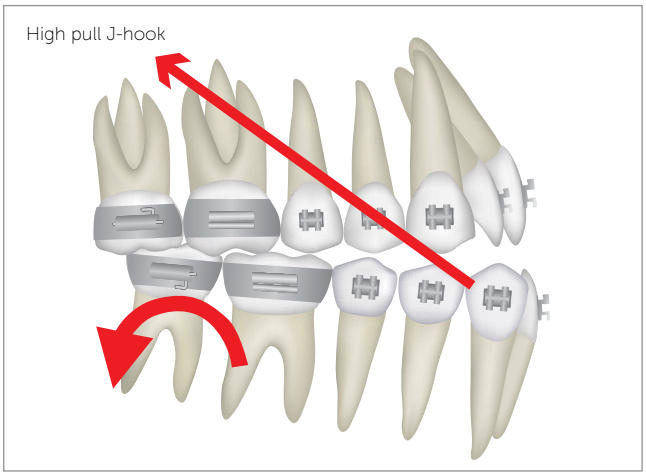
Figure 13 - Initial lateral cephalometric radiograph (**A**) and cephalometric tracing (**B**).

Treatment objectives and alternatives

With no doubt, the best treatment option included a surgical approach with asymmetric mandibular setback; however, this alternative was completely discarded by the patient and her parents. It was also proposed as treatment alternative a compensatory orthodontic treatment, with extraction of the second upper premolars and the first lower premolars, and the use of extraoral headgear (high-pull J-hook) on the lower arch during the retraction of canines and incisors. The achievement of this resource was pointed as indispensable for treatment success. With its use an efficient vertical control and maintenance of lower occlusal plane would be achieved, promoting a counterclockwise rotation, fundamental for the correction of the anterior open bite. At the end of treatment, an adequate occlusion was expected, with absence of the exposure of lower incisors in the smile, which would contribute to camouflage the mandibular asymmetry and to give the smile a pleasant esthetics.

Treatment

Facing the refusal of performing a combined orthodontic and surgical treatment, a compensatory orthodontic treatment was done, with second upper premolars and first lower premolars extracted. Associated with that, the use of extraoral high-pull headgear (J-hook) on the lower arch, in order to promote efficient vertical control during treatment, specifically during canine and incisor retraction (Fig 14).



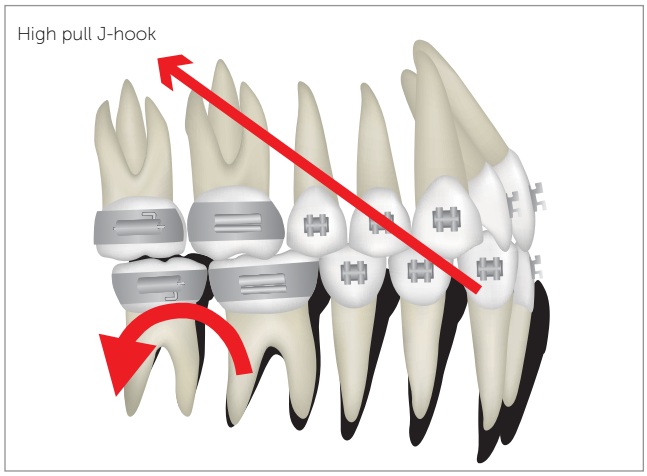


Figure 14 - Illustration of Class III mechanics employed for vertical control, anchored on J-hooks in the lower arch.

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In the upper arch a slow expansion was performed (1/4 turn on alternate days, during 30 days) with a Hyrax expander, with the objective of improving arch form, making it compatible in the transverse direction with the lower arch. Then, standard metal brackets, with no torque or angulations, slot 0.022 x 0.028-in, Edgewise system were placed.

In the lower arch, apart from the fixed appliances, a high pull headgear (J-hook) was used.

After the removal of the Hyrax device, extractions of teeth #15 and #25 were requested, and then the alignment and leveling was performed, with 0.014-in, 0.016-in, 0.018-in and 0.020-in stainless steel arches, respectively. In the lower arch, initially the extractions of teeth #34 and #44 were requested and then the alignment and leveling was performed, with 0.014-in, 0.016-in, 0.018-in and 0.020-in sequential stainless steel wires. With the 0.018 x 0.025-in rectangular wire, the J-hook headgear was adapted on the lower arch, with high pull direction (150 g/side). The patient was instructed to use it for at least 12h/day. It was directly anchored on the arch, hooked to the canines, working as jigs, with the objective of distalizing the lower canines and, at the same time, due to the high pull, promote efficient vertical control, generating a rotation of the lower occlusal plane in the counterclockwise direction – which was favorable for the closure of the open bite (Fig 14). Due to the asymmetry and the greater need for distal movement of tooth #43, after distalization of tooth #33, the J-hook was anchored to a hook welded to the arch between teeth #32 and #33, while the right side would continue to play the role of a jig, moving tooth #43.

Meanwhile, in the upper arch, space closure would be executed in a reciprocal way, with the objective of enabling posterior anchorage loss, together with retraction and uprighting of the incisors, and consequent closure of the open bite.

Then, upper and lower 0.019 x 0.026-in stainless steel arches, with bends and torques were made, individualized, as needed for adequate finishing (Fig 15). The retention on the upper and lower arches, was done with wraparound type removable appliances.

Analysis of results

The main objectives of the treatment were accomplished, establishing an adequate dental relationship, with important repercussion on the general esthetics of the face, and, in a specific way, significative improvement on the smile, with the absence of exposure lower teeth (Fig 15), collaborating for mandibular asymmetry camouflage. It is worth to highlight that a preponderant factor for the success of the treatment was patient collaboration, with the use of extraoral mechanics, resulting in excellent vertical control. With the dental alterations, there was a significative change on the ANB angle, from -2° to 3° (Figs 17, 18 and Table 2).

That fact can be attributed to remodeling of the alveolar processes on lower and upper anterior regions, as response to the retraction mechanics employed. There was also significative improvement on the inclination on lower and upper incisors, with a decrease of 1-NA from 30° to 20°, and from 1-NB from 32° to 24°, effecting directly on the closure of the open bite and on the improvement of facial profile (Figs 17, 18, and Table 2). A Class I occlusion relationship was achieved on canines and molars, and the anterior open bite was corrected. Alignment, leveling, and inclination correction were successfully achieved (Fig 7).

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Figure 15 - Final facial and intraoral photographs.

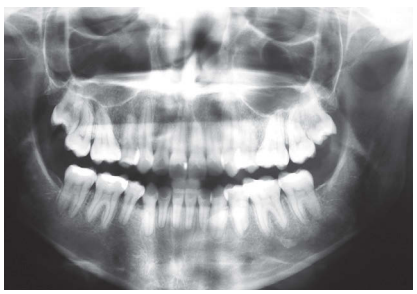


Figure 16 - Final panoramic radiograph.

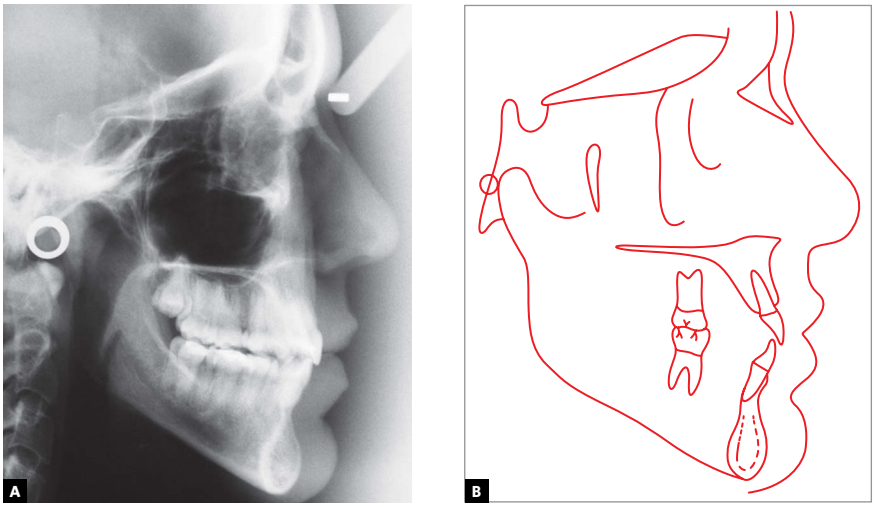


Figure 17 - Final lateral cephalometric radiograph (**A**) and cephalometric tracing (**B**).

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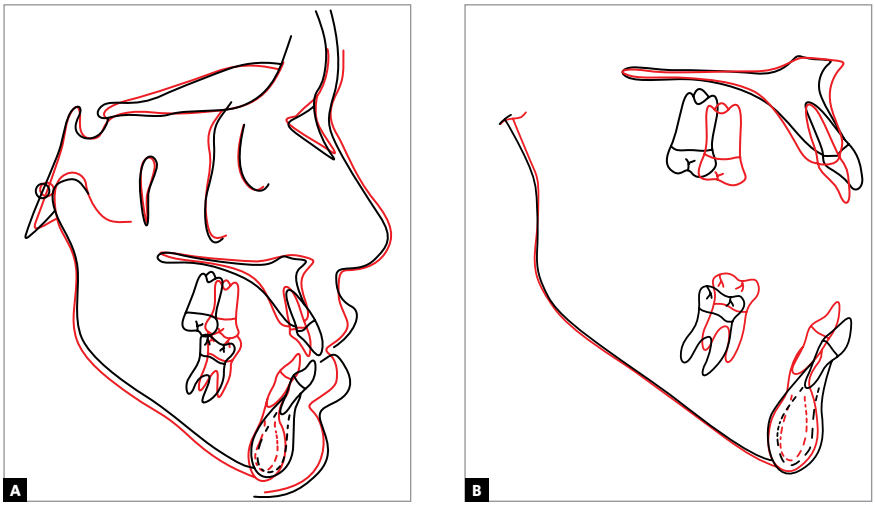


Figure 18 - Total (**A**) and partial (**B**) superimpositions of initial (black) and final (red) cephalometric tracings.

Table 2 - Summary of cephalometric measurements.

	Measures		Normal	A	B	A/B diff.
Skeletal pattern	SNA	(Steiner)	82°	78°	79°	1
	SNB	(Steiner)	80°	80°	76°	4
	ANB	(Steiner)	2°	-2°	3°	5
	Convexity angle	(Downs)	0°	-3°	2°	5
	Y axis	(Downs)	59°	66°	69°	3
	Facial angle	(Downs)	87°	82°	80°	2
	SN-GoGn	(Steiner)	32°	39°	40°	1
	FMA	(Tweed)	25°	37°	40°	3
Dental pattern	IMPA	(Tweed)	90°	93°	86°	7
	1.NA (degrees)	(Steiner)	22°	34°	18°	16
	1-NA (mm)	(Steiner)	4 mm	9 mm	5 mm	4
	1.NB (degrees)	(Steiner)	25°	32°	24°	8
	1-NB (mm)	(Steiner)	4 mm	7 mm	6 mm	1
	$\frac{1}{1}$ – Interincisal Angle	(Downs)	130°	116°	137°	21
	1 – APO (mm)	(Downs)	1 mm	7 mm	2 mm	5
Profile	Upper Lip – S Line	(Steiner)	0 mm	1 mm	-1 mm	2
	Lower Lip – S Line	(Steiner)	0 mm	3 mm	-0.5 mm	3.5

Case 3 – Class III with anterior open bite treated with extractions (#38, #48)

» **Vertical control:** Skeletal anchorage

History and etiology

The patient, 29 years old, presented for initial exam in a good general state of health. His main complaint was related to the presence of anterior open bite, associated with masticatory difficulty. Facial esthetics did not seem to be a concern (Fig 19). With more detailed examination of the occlusion, a disharmony was noticed between the maxilla and the mandible, on the anteroposterior direction. There was reference to Class III on his family medical history.

Diagnosis

Regarding facial features, he presented a dolichocephalic facial type, with a convex profile, lower facial

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Figure 19 - Initial facial and intraoral photographs.

third largely increased and lip incompetence at rest. The lips presented a unbalanced relation, the lower being in front of the upper. He presented adequate exposure of upper incisors, when smiling (Fig 19).

Regarding the dental aspect, he had an Angle Class III malocclusion, with anterior open bite (2 mm), and a -2 mm overjet. Also, an ample upper arch was noticed, with rotations of central incisors and interincisal diastema. There was a reverse curve of Spee on the lower arch, with significative unevenness between posterior and anterior segments of the arch; upper and lower occlusal planes were divergent, and midlines were coincident (Fig 19). The presence of countless gingival recessions was, probably, related to the inadequate and traumatic form with which the patient performed brushing, conjugated to extremely fine periodontal profile, especially on the lower incisor region.

The panoramic radiograph analysis did not show any significant alteration that could contraindicate the performance of orthodontic treatment (Fig 20). Cephalometric evaluation indicated important skeletal disharmony, with ANB = -1° (SNA = 79° and SNB = 80°), with poor mandibular growth in the vertical direction (SN-GoGn=34°), highlighting the vertical hyperdivergent facial aspect. Upper incisors were tipped buccally and lower ones were vertical, in relation to the basal bone (those observations can be better evaluated on Fig 21 and Table 3).

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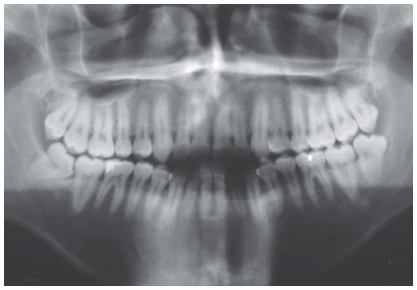


Figure 20 - Initial panoramic radiograph.



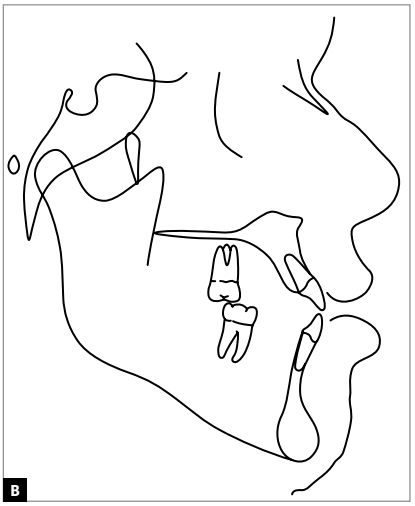


Figure 21 - Initial lateral cephalometric radiograph (**A**) and tracing (**B**).

Treatment objectives and alternatives

Initially, orthosurgical treatment, probably with need of maxillomandibular manipulation, was presented as the only option to establish adequate esthetic and functional patterns. The surgical alternative was completely discarded by the patient. As another alternative, a compensatory orthodontic treatment was suggested with extraction of lower third molars, the use of skeletal anchorage on the upper arch (mini-implants) to support Class III intermaxillary mechanics, in order to reproduce the system of directional forces presented by Tweed-Merrifield, during distal lower tooth movement.[12] The achievement of this mechanic was pointed as indispensable for treatment success. With its use, efficient vertical control and maintenance of inferior occlusion plane would be achieved, promoting its rotation in a counterclockwise direction, fundamental for the correction of the anterior open bite. At the end of the treatment, an adequate occlusion was expected to be found, with counterclockwise rotation of the lower occlusal plane and decrease of lower incisor exposure in the smile. Periodontal control, associated with adequate brushing technique, was fit to minimize progression of recession, which was also part of the objectives.

Treatment

Even with the absence of complaint about facial esthetics, it was clear that the best option for the treatment would be the combination of orthodontics with orthognathic surgery. The patient readily manifested his aversion to surgery, questioning the alternatives. After careful analysis of the case, a compensatory orthodontic treatment was proposed, with the purpose of offering satisfactory occlusion with no worries about changes in the facial aspect. The greatest concern on the elaboration of the treatment plan was due to the need of efficient vertical control, because of the hyperdivergent pattern of the patient. The control of the lower occlusal plane, as well as its rotation in a counterclockwise direction, was made necessary to promote closure of the anterior open bite. This aspect was obtained with the use of specific mechanics, with origin in points of skeletal anchorage on the upper arch (mini-implants) (Fig 22). The mechanic described followed the directional force principles of Tweed-Merrifield technique.[12]

The treatment itself had its start with the extraction of the lower third molars, the installation of mini-implants between teeth #15-#16 and #25-#26, and the setting of 0.022 x 0.028-in Edgewise standard metal brackets in both arches, except on the lower incisors that were included only in a posterior step of the treatment.

The superior arch had its normal sequence of alignment and leveling with 0.014-in NiTi wire, as well as 0.016-in; 0.018-in and 0.020-in, and finally with a 0.018 x 0.025-in, stainless steel archwire. In the lower arch a specific mechanic was applied to perform vertical control and distalization of the lower

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teeth after the removal of the third molars. The mini-implants on the posterior region of the upper arch worked as points of skeletal anchorage, in order to apply intermaxillary mechanics with Class III direction. The presence of those devices resulted on several advantages, such as: 1) It completely eliminated the undesirable effects of intermaxillary mechanics on the upper arch, which would provide an even bigger projection of upper incisors. 2) The direction of the high-pull on the anterior region of the lower arch gave a vigorous vertical control, promoting counterclockwise rotation of the lower occlusal plane, so important for the evolution of the treatment during distalization of the lower teeth and closure of the open bite, quite similar to the high pull J-hook extraoral device on the lower arch, as described and applied on the technique by Tweed-Merrifield[12] (Figs 22 to 25).

As the posterior region of the lower arch presented a relative degree of alignment and leveling, the treatment started with a 0.017 x 0.022-in rectangular stainless steel archwire, passively adapted, highlighting only the presence of tip back bends with intensity of about 30° on teeth #37 and #47.

Molar correction was performed with the help of long sliding jigs that received elastics from mini-implants on the upper arch (Fig 23). Those jigs were near the tubes on teeth #37 and #47, extending anteriorly until the canine distal surface. The force exerted by the elastics (150 g) on the high pull potentiated the distal inclination bends of teeth #37 and #47, distalizing them, at the same time in which promoted efficient control of the lower occlusal plane (Figs 22 and 23). As the second molars were distalized and reached their proper place, the jigs were being transferred to the next molar, and so on.

When posteroinferior teeth had already been considerably distalized, so that some diastemas appeared between the canines and the lateral incisors, the incisors were included in the treatment. A 0.018-in archwire with "T" loops, to allow for the correct alignment and leveling of these teeth, replaced the rectangular arch. However, the intermaxillary mechanics continued.

After alignment and leveling of incisors, a new 0.018 x 0.025-in rectangular lower archwire was made. Intermaxillary mechanics persisted until the achievement of the molar and canine Class I occlusion, and the establishment of adequate overbite and overjet.

Then, upper and lower 0.019 x 0.026-in stainless steel archwires, in an ideal form were made, individualized as needed for adequate finishing. The retention on the upper arch was done with a wraparound type plate, and on the lower arch with intercanine fixed retainer made with 0,032-in wire.

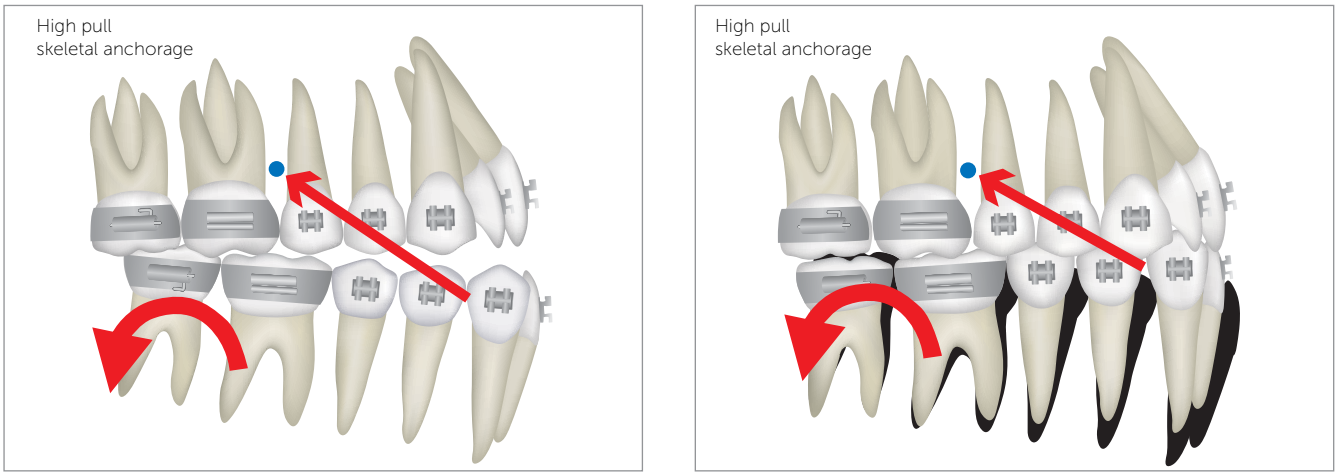


Figure 22 - Illustration of the Class III mechanics employed in the vertical control, anchored in mini-implants on the upper arch, between the first molars and second premolars.

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Figure 23 - Initial step of treatment. Class III mechanics supported by mini-implants (upper arch) and with sliding jigs (lower arch).

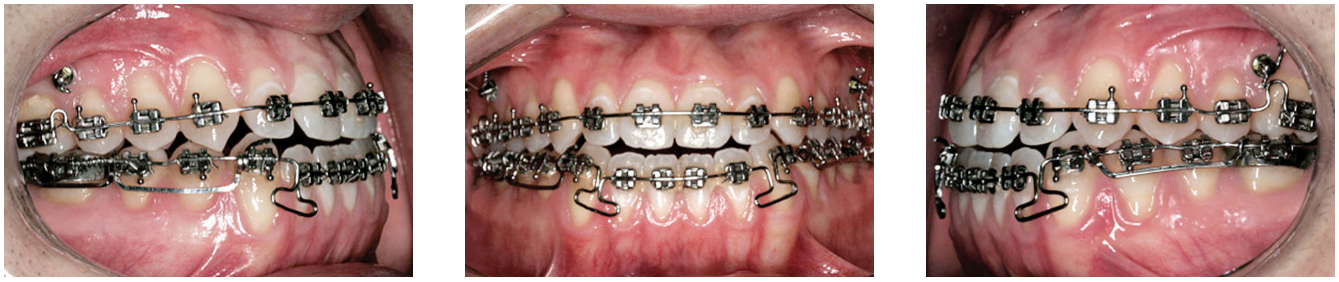


Figure 24 - Intermediate treatment step. Lower incisors were included after reasonable distalization of the other teeth in this arch. Observe the control of the lower occlusal plane, as well as the closure of the bite, produced by Class III mechanics supported by mini-implants.

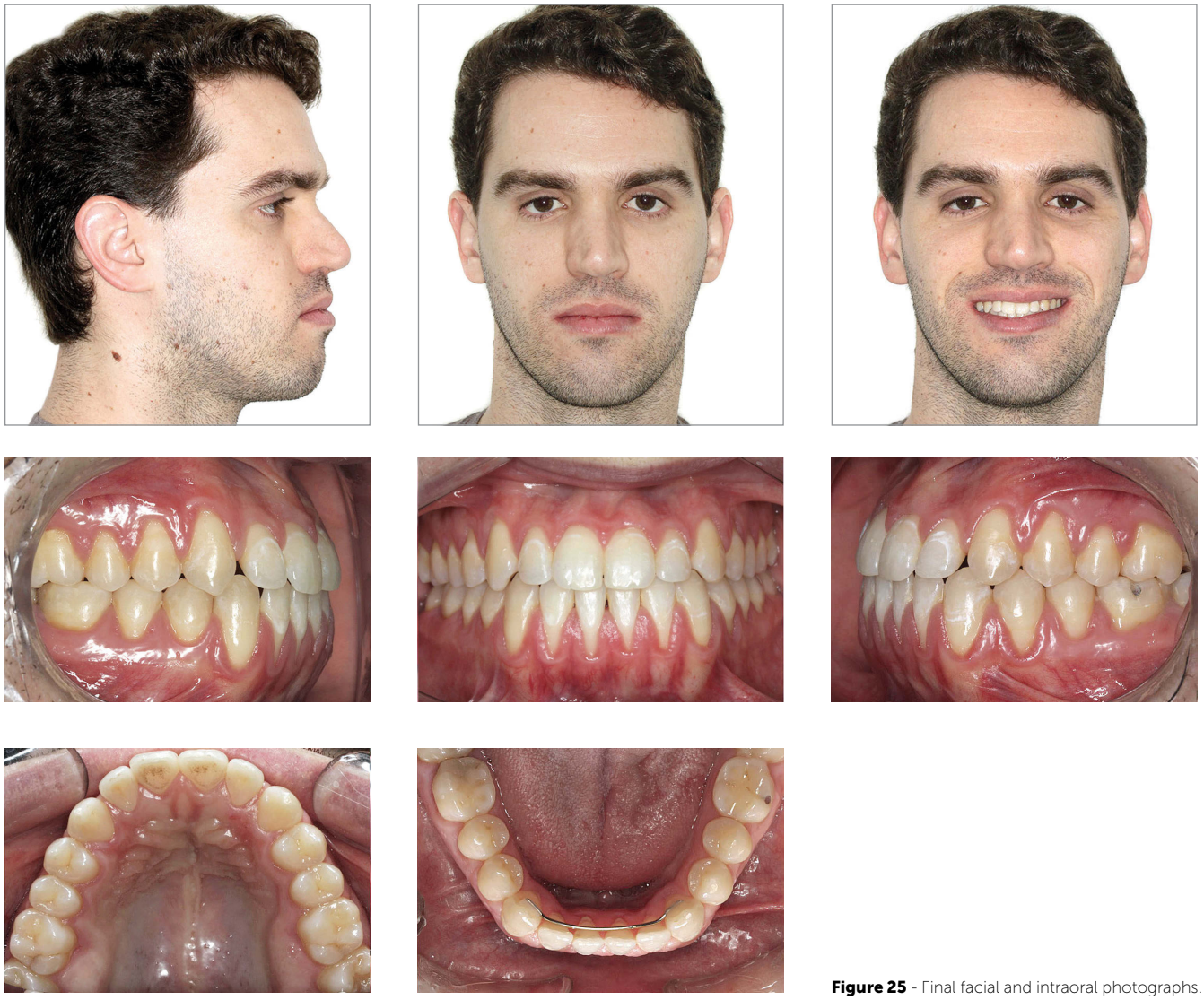


Figure 25 - Final facial and intraoral photographs.

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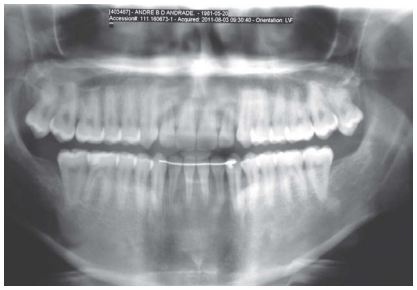


Figure 26 - Final panoramic radiograph.

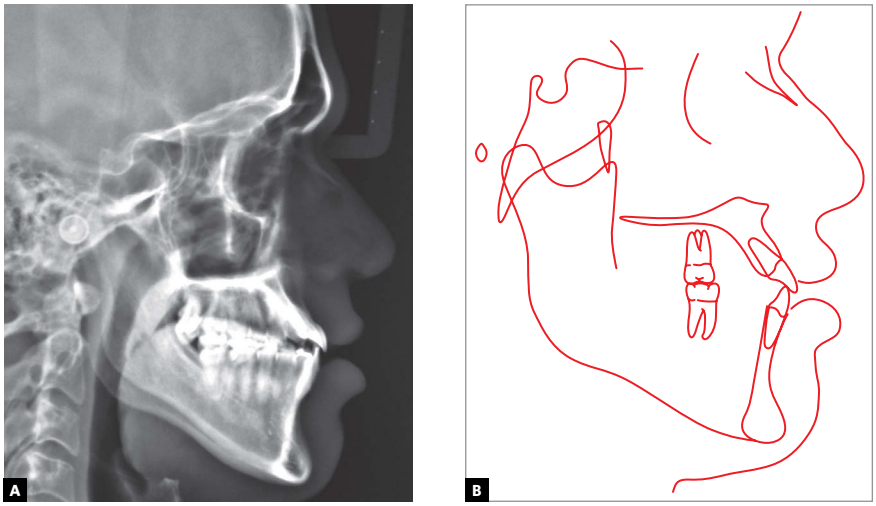


Figure 27 - Final lateral cephalometric radiograph (**A**), and cephalometric tracing (**B**).

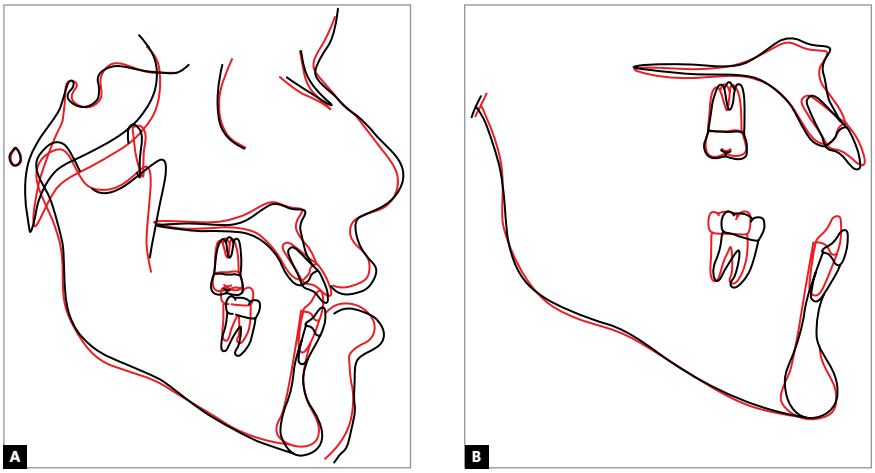


Figure 28 - Total (**A**) and partial (**B**) superimpositions of initial (black) and final (red) cephalometric tracings.

Table 3 - Summary of cephalometric measurements.

	Measures		Normal	A	B	A/B diff.
Skeletal pattern	SNA	(Steiner)	82°	79°	78°	1
	SNB	(Steiner)	80°	80°	79°	1
	ANB	(Steiner)	2°	-1°	-1°	0
	Convexity angle	(Downs)	0°	-6°	-7°	1
	Y axis	(Downs)	59°	57°	57°	0
	Facial angle	(Downs)	87°	94°	93°	1
	SN-GoGn	(Steiner)	32°	34°	32°	2
	FMA	(Tweed)	25°	27°	24°	3
Dental pattern	IMPA	(Tweed)	90°	85°	83°	2
	$\underline{1}$.NA (degrees)	(Steiner)	22°	33°	42°	9
	$\underline{1}$-NA (mm)	(Steiner)	4 mm	8 mm	11 mm	3
	$\overline{1}$.NB (degrees)	(Steiner)	25°	23°	18°	5
	$\overline{1}$-NB (mm)	(Steiner)	4 mm	7 mm	6 mm	1
	$\frac{1}{1}$ –Interincisal Angle	(Downs)	130°	124°	122°	2
Profile	Upper Lip – S Line	(Steiner)	0 mm	0.5 mm	0 mm	0.5
	Lower Lip – S Line	(Steiner)	0 mm	6 mm	4 mm	2

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Analysis of results

The main objectives of the treatment were accomplished, establishing an adequate dental relationship, with significative improvement on esthetics of the smile, with the minimization of lower incisor exposure (Fig 25). No important repercussion was noticed on general facial esthetics, since that was not an original objective. It is worthy to highlight that a preponderant factor for the success of the treatment was patient collaboration on the use of intermaxillary elastics. Skeletal alterations can be summarized on mandibular counterclockwise rotation, with decrease of 2°, at SN-GoGn (from 34° to 32°), proving the efficient control of used mechanics (Figs 27 and 28, and Table 3). From the dental point of view, there was and increase of upper incisor inclination, with 1-NA from 33° to 42°, and slight retroinclination and extrusion of lower incisors, 1-NB from 23° to 18°, effecting directly on the closure of the open bite (Fig 27 and 28, and Table 3).

A Class I relationship on canines and molars was obtained, and the anterior open bite was corrected. Alignment, leveling, and inclination and rotation correction were successfully achieved (Fig 17). There was a slight increase of gingival recessions on the region of lower incisors, but not in a single moment that fact could be attributed to dental movement, since those movements were slowly accomplished, with lingual inclination. The patient admitted to persist with inadequate brushing, which surely contributed to this situation. He was referred to evaluation by a periodontist, regarding the need for performing free gingival grafts.

CONCLUSION

On the importance of vertical control on Class III orthodontic compensatory treatment (camouflage), we understand that:

1. The control of the occlusal plane and of the mandibular plane provided by efficient and easily applied mechanics can bring benefits that characterize Class III compensatory treatment as a great alternative for the resolution of those problems. It is important to highlight that there are limitations, and that not every case can be treated in a compensatory manner.
2. Orthodontic camouflage is not able to produce great changes on the face, neither to correct asymmetry, that is, it should not be used on patients who yearn for great facial esthetics alteration, who, therefore, are candidates to orthognathic surgery.
3. It is important to highlight that, in cases treated with orthodontic camouflage, skeletal discrepancy remains. Therefore, it is most important to verify in detail the patient's complaint before beginning any kind of treatment. That prevents future frustration regarding the result achieved at the end of the treatment.[3]
4. Orthodontics is not a exact science, therefore, it is the clinical experience of the professional that will dictate treatment planning, always paying attention to the limitations and particularities of each patient, in order to raise the possibilities of treatment success.

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Clinical trials are among the best evidence for clinical decision making. To be considered a clinical trial a research project must involve patients and be prospective. Such patients must be subjected to clinical or drug intervention with the purpose of comparing cause and effect between the groups under study and, potentially, the intervention should somehow exert an impact on the health of those involved.

According to the World Health Organization (WHO), clinical trials and randomized controlled clinical trials should be reported and registered in advance.

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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.

2. Portal for promoting and registering clinical trials

With the purpose of providing greater visibility to validated Clinical Trial Registers, WHO launched its Clinical Trial Search Portal (http://www.who.int/ictrp/network/en/index.html), an interface that allows simultaneous searches in a number of databases. Searches on this portal can be carried out by entering words, clinical trial titles or identification number. The results show all the existing clinical trials at different stages of implementation with links to their full description in the respective Primary Clinical Trials Register.

The quality of the information available on this portal is guaranteed by the producers of the Clinical Trial Registers that form part of the network recently established by WHO, i.e., WHO Network of Collaborating Clinical Trial Registers. This network will enable interaction between the producers of the Clinical Trial Registers to define best practices and quality control. Primary registration of clinical trials can be performed at the following websites: www.actr.org.au (Australian Clinical Trials Registry), www.clinicaltrials.gov and http://isrctn.org (International Standard Randomized Controlled Trial Number Register (ISRCTN). The creation of national registers is underway and, as far as possible, the registered clinical trials will be forwarded to those recommended by WHO.

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