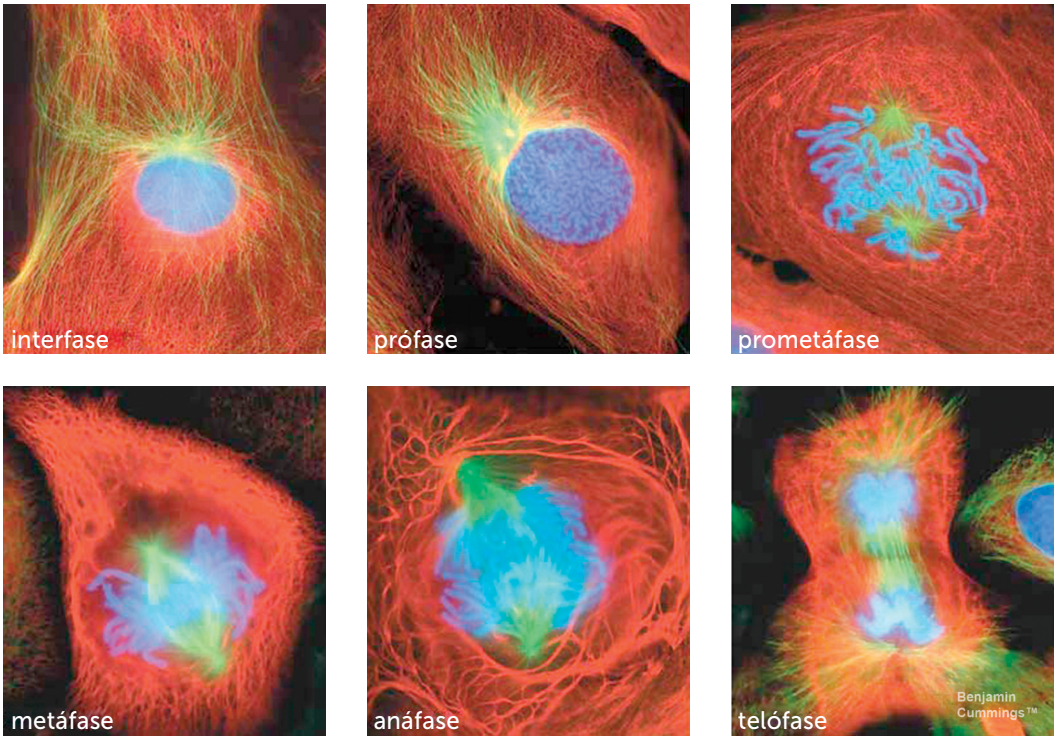
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Adjustments to the editorial process

"People fear change. I fear that things never change." (Chico Buarque)

When an article is submitted to *Dental Press Journal of Orthodontics*, the editor-in-chief carries out an initial analysis and decides whether that article is suitable for publication. Should that be the case, the article is sent to three or four reviewers. However, it is immediately sent back to the author if the editor-in-chief considers it unsuitable for publication. For such consideration, the following criteria are applied: low originality level, articles that replicate well-established scientific knowledge only or case reports that do not introduce any important innovations in the treatment of the malocclusion reported. We believe that speeding up this process, especially in cases of refusal, eases the feeling of disappointment caused by a negative response, particularly for young authors.

The process, as it is nowadays, has led some authors to write letters to the editor. In fact, not many letters have been sent, but all questions have been carefully and respectfully analyzed and answered. As in any other submission system, our *modus operandi* is susceptible to flaws. It is important to emphasize that there is a probability of error in the evaluation process carried out by the editor-in-chief with regard to the quality of the submitted article.

The *Dental Press Journal of Orthodontics* (DPJO) editorial board has continuously discussed all the questions involved in the peer-review process. And taking advantage of the considerable number of submissions — a fact that is associated with the indexation of DPJO on PubMed[1] —, we decided to introduce a slight change to our editorial process. From 2014 onwards, all submitted articles will be forward to two associate editors for an initial analysis. Should both decide that the article is of low priority, it will be sent back to the author. Conversely, should at least one of the editors decide that the article is suitable for publication, it will continue on the submission process and will be thoroughly analyzed by a group of three to four reviewers.

This initial analysis aforementioned will be carried out by a committee formed by: Daniela Garib, Flavia Artese, Matheus Pithon, Ildeu Andrade, Fernanda Angelieri and Leandro Marques. These eminent Brazilian scientists will be coordinated by the editor-in-chief and will scrutinize the article in order to assess its originality, the quality of its English and whether or not it is in accordance with the standards of the journal.

The aim of this new assessment method is to reduce any bias in the peer-review process of this periodical.

David Normando – editor-in-chief
(davidnormando@hotmail.com)

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Matheus Melo Pithon*

PERIODONTIUM REPAIRS ITSELF AFTER BEING TRAUMATIZED BY THE MINI-IMPLANT

Orthodontic anchorage has been cause of concern to orthodontists since the specialty beginnings. It is no exaggeration to say that its control is a determining factor regarding the success or failure of orthodontically treated cases. With the advent and popularization of orthodontic mini-implants, anchorage problems were minimized and, often, eliminated. The popularization of mini-implants occurred due to favorable characteristics such as: effectiveness, facility for insertion and removal, reduced size, low cost, etc. However, despite many positive aspects, complications may occur when using it. The possibility of root injury is specially mentioned. However, what would be the real repercussions of these lesions on the healthiness of the injured teeth? In search of an answer to this question, Brazilian researchers[1] developed a systematic review aiming at assessing root repair after contact of the mini-implant with the root of adjacent teeth. The results revealed that the quality of root repair depends on the damage caused during mini-implant insertion. According to the authors, when the root injury is limited to the dentin and cement area, complete periodontal repair can occur. It is worth emphasizing that, although the results are favorable to repair, we must be careful to avoid injuries to the periodontium, considering the lack of long term studies.

INTRAORAL SCANNER PRESENTS LOW ACCURACY FOR PRODUCTION OF VIRTUAL MODELS

As any branch of Science, Orthodontics evolves daily. At each new discovery, Orthodontics becomes better. Today, the scanning of orthodontic models has been much discussed. The high costs and difficulties on obtaining a good orthodontic model, associated to the lack of space for storage, have stimulated this process. Despite incipient, the scanning of models is a tendency that will hardly stop occurring. It is a matter of time. With no doubts, in the very near future, digital models will supplant physical models made of plaster. When thinking of obtaining digital models, nowadays, the main methods are: scanning of the plaster cast, obtained from traditional impression; or scanning of the patient's mouth, using a digital scanner. However, which one would be the most accurate method? In search of this answer, German researchers[2] developed a study in which they assessed the accuracy of the scanning directly in the mouth and of the model (Fig 1). The results showed low accuracy for the intraoral scanning performed by the iTero scanner (Align Technology, USA).

The authors claim that the imprecision occurred due to the presence of saliva and to the reduced intraoral space. High accuracy was found on the scanning of models. Despite these results, the authors emphasize that virtual models, from intraoral scanning, can be used for elaboration of treatment plan and for production of tooth-supported appliances.

BRONCHIAL ASTHMA IS A DETERMINING FACTOR FOR REDUCTION OF AIRWAYS

Every day, the treatment with a multidisciplinary approach receives more emphasis. Orthodontics, as Health specialty, cannot escape this commitment. The treatment of patients with respiratory problems became a routine in orthodontic offices, and the professional must be prepared for the diagnosis and installation of therapeutic actions for its correction or control.

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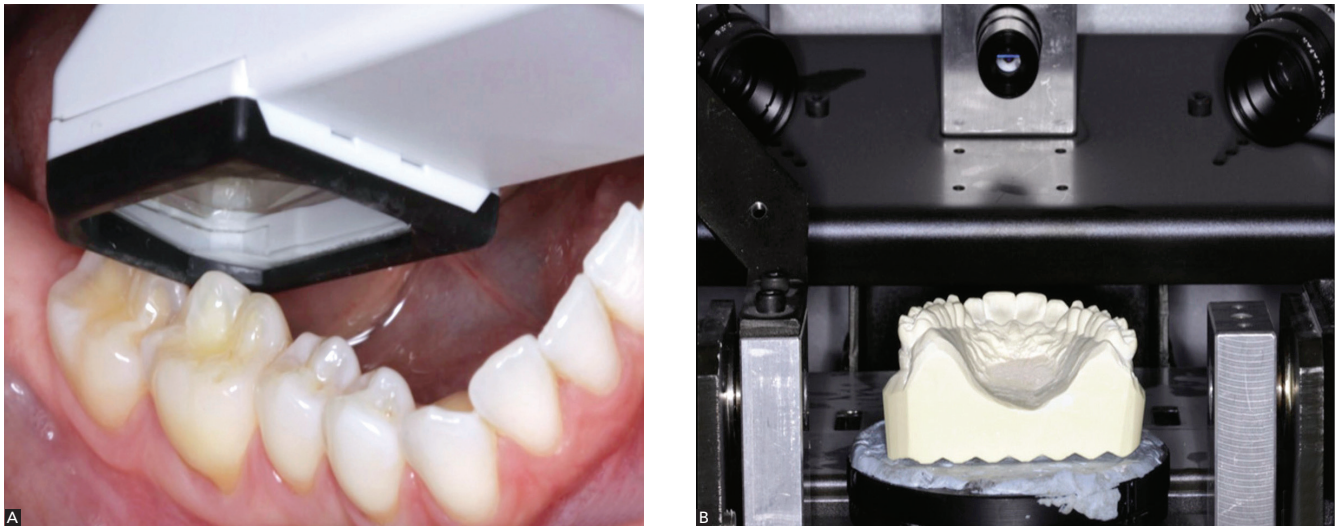


Figure 1 - A) Intraoral scanning using iTero scanner. B) Model scanning using the D250 scanner (Source: Flugge et al,[2] 2013).

Among the several respiratory problems that can result in development of malocclusion, bronchial asthma arouses special attention, since this disease affects about 300 million people worldwide. When reading this text, you might ask yourself, but how? Wouldn't the asthma be related only with the lower airways? There are studies, available in literature, which contradict this statement. However, these studies use two-dimensional images for these assessments. In the search of more reliable answers, Brazilian researchers[3] developed a study using computed tomography (Fig 2) in order to assess the upper air space, in individuals with asthma. The results showed that patients with bronchial asthma present significant reduction of the airway dimensions. It is a result of great clinical importance, since, more than never, a multidisciplinary interaction will be necessary to solve this problem for the orthodontic patient.

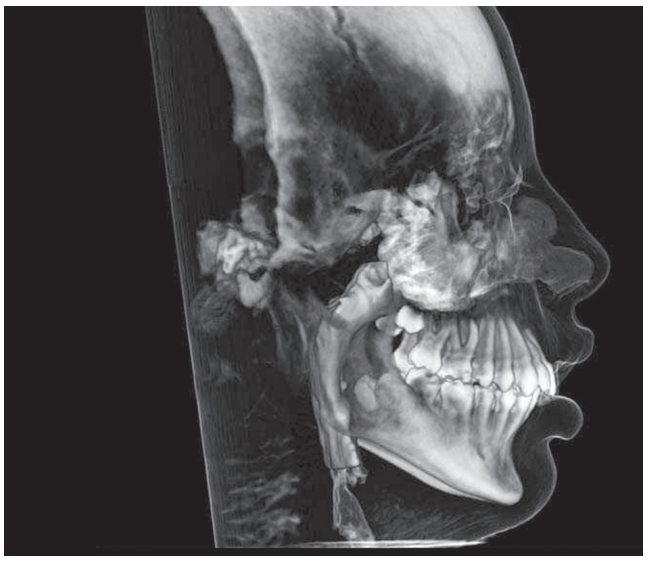


Figure 2- Total volume of the upper airways obtained by the Dolphin program. (Source: Bandeira et al,[3] 2013)

PRIOR APPLICATION OF SODIUM HYPOCHLORITE INCREASES THE ADHESION OF BRACKETS BONDED WITH GLASS IONOMER CEMENT

Bonding of orthodontic accessories directly to the enamel provided one of the greatest leaps in Orthodontics during the last decades. Today, we count on materials that present good resistance, biocompatibility and color stability. Despite all these achievements, one characteristic still lacks for an ideal bonding material: continuous release of fluoride during orthodontic treatment. Not rarely, we find, at the end of treatment, white spot lesions around the brackets. According to current knowledge, the material that best performs this role, of retaining and releasing fluoride, is the glass ionomer cement. However, these materials still lack improvements in their mechanical properties, to make them as resistant to masticatory effort and to orthodontic mechanics as the composites. Much has been suggested in the literature to improve the adhesion of this material, such as enamel deproteinization before bonding, when using these materials. The creators of this technique had in mind that using deproteinizing agents before the acid conditioning, would provide better removal of organic

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substances, improving adhesion. Attempting to prove the effectiveness of this technique, when bonding with glass ionomer cement, Brazilian researchers[4] developed a laboratory study in teeth with and without previous enamel deproteinization. An increase on bonding resistance was observed, both with conventional glass ionomer cement and with composite. New clinical studies must be performed in order to prove the results obtained in laboratory.

LINGUAL BRACKETS PRESENT GREATER PLAQUE RETENTION, GINGIVAL INFLAMMATION AND STREPTOCOCCUS MUTANS THAN BUCCAL BRACKETS

The search for esthetic orthodontic appliances is a constant, nowadays. The increase of adult patients in orthodontic offices has stimulated the search for treatments with increasingly less visible appliances. Among the appliances with this purpose, there is the ceramic and plastic brackets, thermoplastic plates and lingual appliances. These latter have gained many followers, recently, because they are located in the less visible area. However, many are the doubts regarding these devices, for instance, if they would be more hygienic or not than the conventional buccal brackets.

In order to elucidate this clinical questioning, Italian and Turkish researchers[5] developed a clinical study in which they assessed the plaque index, gingival bleeding index, salivary flow rate, saliva buffer capacity, salivary pH and amount of *Streptococcus Mutans* and of *Lactobacillus*. The results showed that lingual brackets had greater plaque retention in the first eight weeks after bonding, as well as greater gingival bleeding and number of *Streptococcus Mutans*. These results must be considered when choosing the type of appliance, especially when the patient already presents poor hygiene, before starting orthodontic treatment.

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Mouthwashes with hydrogen peroxide are carcinogenic, but are freely indicated on the Internet: warn your patients!

Alberto Consolaro[1]

It all began in Ancient Egypt where people used to bleach their teeth with antiseptic mouthwashes made of urea from human urine. Teeth harmony is promoted by expression of feelings, communication, a real window of the brain and its content! Tooth bleaching products are medicines, not cosmetics! Mouth washing with hydrogen peroxide is an illogical and dangerous procedure! Hydrogen peroxide must be used in one's mouth only when employed by a dentist who has been properly instructed to protect the mucosa, preventing it from receiving these products. How and for how long these products are going to be used require caution in order to avoid or decrease any adverse effects on the tissues. Many websites instruct people on how to purchase and prepare hydrogen peroxide so that it is used as an antiseptic mouthwash and tooth bleaching agent. Some websites even refer to dentists as "exploiters", accusing them of not instructing patients properly. In this article, we aim at providing evidence and information upon which dentists and assistants may base their thinking as well as their opinion and procedures regarding "the indiscriminate and free use of hydrogen peroxide in the mouth, on teeth and oral mucosa". Those websites, blogs and social network profiles trespass the limits of public trust and should be immediately sued by the government for committing a crime against public health.

Keywords: Hydrogen peroxide. Mouth washing. Rinsing. Teeth bleaching. Teeth whitening.

It all began in ancient Egypt where people used to bleach their teeth with antiseptic mouthwashes made of urea from human urine, although no object related to teeth cleaning has yet been found in Egyptian tombs.[4,18]

One of Aristotle's disciples reported that: shaving and having white teeth are a virtue that shall be cultivated. The Romans taught the Greek to clean their mouth and teeth with pumice, talcum and coral powder. The Athenian Diocles of Carystus wrote: Every morning, brush your gingiva and your teeth using your fingers with mint powder in order to remove any food debris.[18] In the Roman Empire, bone ash, ground eggshell and ground coral mixed with honey formed a potassium carbonate and sodium-based product used for teeth cleaning and whitening.

Appearance is highly valued in nearly all human activities. The mouth and the smile are determining factors of beauty, including inner beauty. Teeth are in harmony with the expression of feelings and human communication. My assertion that "Being smart is being happy!" implies joy, showing mouth and teeth, the real outer expression of our inner self or of our "heart", a window to our

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brain and its most valuable content! In the most developed and socially assisted societies, the integrity of teeth has been increasingly preserved as a result of prevention against caries and periodontal disease. Periodontal disease is related to dental plaque which is a result of lack of education and poor oral hygiene. The more educated and assisted the people are, the more they value subtleness and details, inducing patients to worry about the appearance of their teeth, gingiva and lips. The following are among some of the concerns raised:

» Tooth color, shape and size.
» Tooth positioning and arch symmetry and its harmony with lips and smile.
» Lamellas, small fractures and loss of structure due to friction, abrasion, abfraction and erosion.

Esthetics has been increasingly valued, and each detail represents a differential within this competitive world. Esthetic procedures and products are widely known, applied and negotiated. In human resources, selecting candidates to play specific roles in the market depends on the candidate's appearance, beauty and visual seduction power.

To be classified as cosmetic, the products cannot be used for any treatment and must not change body physiology. Teeth bleaching products should not be classified as cosmetic products because they change the physiology of where they act — for instance, the enamel, dentin, pulp, gingiva and oral mucosa. Using bleaching gel without supervision may not only cause hypersensitivity, but also stain the teeth.

During a meeting held with the Brazilian Health Surveillance Agency (ANVISA), some Brazilian dental organizations requested a public consultation on which it was proposed that a new regulation on the commercialization of tooth bleaching agents should be introduced. Such regulation would require that tooth bleaching agents were only sold under prescription, given that these agents are not classified as cosmetics, but as medicines. These organizations are: Regional Council of Dentistry/São Paulo, Association of Dental Surgeons/São Paulo (APCD Central), representatives of the Brazilian Association of Medical, Dental, Hospital and Laboratory Supplies and Equipment Industry, and the dental industry which produces tooth bleaching products. The changes proposed involve regulating and establishing criteria for packaging, labeling, distributing and controlling tooth bleaching agents and classify them as medicines. They will be sold on prescription written by a dental surgeon and under supervision. Additionally, prescription will have to be retained, as it happens with antibiotics, in Brazil. Classifying tooth bleaching agents as medicines require that they have a red label on their package. The regulation stipulates that whitestrips and tooth bleaching products or agents be sold at drugstores and on the internet only on prescription.

WHAT IS THE PURPOSE OF THIS ARTICLE?

Any professional who is committed to Dentistry and public health issues must induce patients to ponder on the responsibilities related to themes that are important to enlighten professionals, technicians, manufacturers and end-user patients.

Ignorance, or lack of knowledge, opens the door to opportunists who aim at achieving success and wealth at any cost, at the expense of anyone and not complying with human and social values previously established.

On the internet, there is a wide range of websites that recommend and teach step by step, with videos and other resources, how to purchase and prepare hydrogen peroxide to be used as mouthwash and as an antiseptic solution that cleans and bleaches the teeth. These websites even refer to dentists as "exploiters", accusing them of not instructing patients properly because they wish to earn profits, only.

Even though this article seems to be redundant, it aims at informing, as we have already done in previously published periodicals that deal with the same theme, and laying the basis upon which dentists and assistants of all specialties may base their thinking as well as their opinion and procedures regarding "the indiscriminate and free use of hydrogen peroxide in the mouth, on teeth and oral mucosa".

It is of paramount importance that we highlight the fact that hydrogen peroxide is harmful and plays a major role in chemical carcinogenesis that occurs not only in the mouth, but also elsewhere. Researches reveal the induction of carcinomas and adenocarcinomas in the duodenum as well as all over the gastrointestinal tract.[10-13]

UNDERSTANDING ORAL CHEMICAL CARCINOGENESIS

When chemical substances act in the oral mucosa, they cross its most superficial and thin layer and penetrate the epithelial cells. These substances may reach the

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nucleus of the cell where the 46 chromosomes that contain the DNA are and in which the 25 thousand pieces of information that guide body functioning, known as genes, are found.

» The initiation stage: the beginning of chemical carcinogenesis. A chemical substance may irreparably harm the DNA structure and, as a consequence, the genes that control, directly or indirectly, cell proliferation. This stage, known as initiation, remains latent and does not act in the cell and/or the tissue. It begins with the action of the chemical agent and ends when changes are detected in cell structure.

» The promotion stage: stimulation of chemical carcinogenesis. Some substances cannot initiate any changes in DNA, but if they act upon it, they can promote phenotypic expression of changes initiated by other chemicals. From that point onwards, those that have been initiated begin to proliferate, and a new cell population is formed. This stage is known as promotion: the promoting agents are also known as carcinogens, since they increase the activity of the carcinogenic initiating agents and speed up neoplastic cell transformation.

Due to being abundant in the environment, the promoting agents play an important role in the prevalence of malignant neoplasm. It may be of chemical nature, but promoting agents may also be of biological and physical nature. Promoting agents do not cause neoplasms alone, they act over initiated cells.

We often devalue environmental factors as carcinogenic agents. Such factors include, but are not limited to: sodium nitrate present in smoked meat, cyclamate in artificial sweeteners, glutamate in food thickener, benzopyrene and hydrocarbons present in tobacco, and aflatoxin produced by a fungus present in badly conserved grains (peanut, for example).

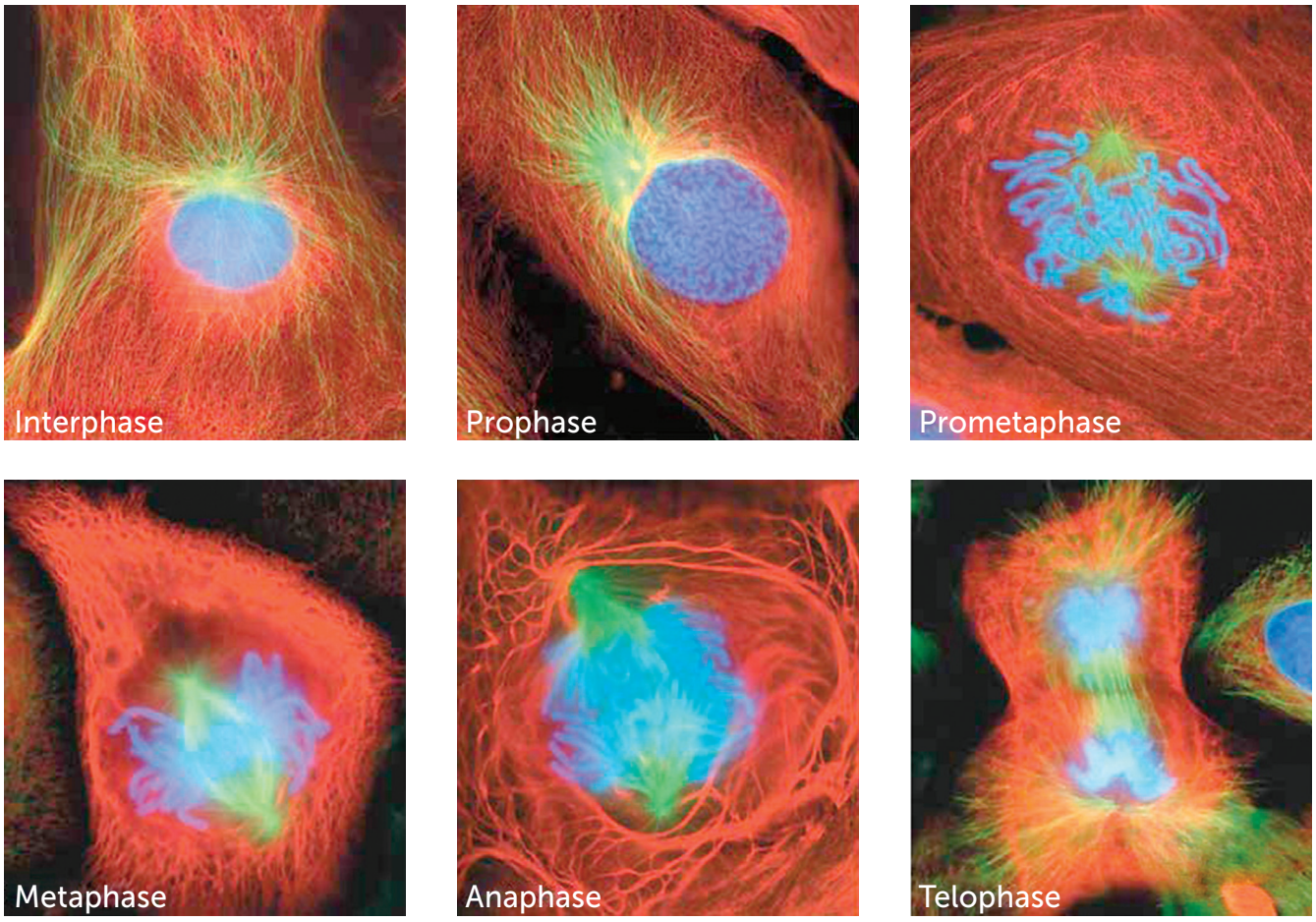


Figure 1 - Mitosis phases for copy/duplication of genes. The mitosis process of each one of the 10 trillion cells of the human body continuously occurs and duplication of the 25 thousand genes represents an opportunity for initiating and promoting agents to act. Each chromosome (in blue) has an average of 1,000 genes that will be duplicated in each mitosis process. All changes are summed up over time.

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Tooth bleaching agents, all hydrogen peroxide-based, are carcinogenic agents. In other words, they potentiate the action of other chemicals (which are widely present in our daily routine) over the DNA of cells present in the oral mucosa, just like alcohol does. This effect on the DNA, which is produced by hydrogen peroxide, has been proved by many researches.[1,10,11,12,13,17,19,20]

» The progression and clinical expression stages. In the progression stage, the initiated and promoted cells proliferate. The period is extended until clinical or imaginologic onset of neoplasm occurs, and that is when the period of clinical expression begins and the lesion can be clinically diagnosed as cancer. Some chemical agents may contribute to slow down or speed up both stages (progression and clinical expression).

» Influence of age, frequency of use and chemical concentration. Out of the three characteristics mentioned, when carefully assessed by experimental studies, the most important one is the frequency of application and use of a chemical substance. Age and sex did not prove to be decisive factors in chemical carcinogenesis, whereas concentration presented little influence, since low concentrations did not result in substantial effects.

Using hydrogen peroxide and alcohol on a daily/weekly basis encourages the promotion of malignant neoplasm in the oral mucosa. Alcohol, for instance, potentiates in 50 times the harm caused by tobacco. Mouth washing with hydrogen peroxide, using products made with alcohol or drinking alcohol everyday may lead to the risk of oral chemical carcinogenesis.[5,14]

IF WE SHOULD BE CAREFUL WITH TEETH WHITENING, WE SHOULD BE EVEN MORE CAREFUL WITH HYDROGEN PEROXIDE USED AS MOUTHWASH ON A DAILY BASIS!

It is worth noting that tooth bleaching agents are based on the effects of hydrogen peroxide acting on dental tissues. Their concentration, presentation, package, chemical formula and other variables result in generating hydrogen peroxide.

Also known as urea peroxide, sodium perborate, carbamide peroxide or other less common names, the hydrogen peroxide may have deleterious effects on the enamel, dentin, cementum, pulp and gingiva.[6] These names vary according to the presentation and formulation of the product. However, if both formulation and presentation of the product are controlled, and if the product is properly applied by a professional who takes the appropriate compensatory measures, its use is safe.[8]

In the oral mucosa, hydrogen peroxide potentiates the effect of many other carcinogenic agents found in patient's mouth. These carcinogenic agents may originate from food, cosmetics, hygiene products, pesticides, herbicides, tobacco, alcohol, virus, among others.[1,17] Such potentiation happens due to the fact that these products are promoting agents of oral chemical carcinogenesis.

There are many carcinogenic products available for sale, for instance: alcoholic beverages, cigarettes, ground tobacco, medicines, insecticides and others. These products are sold directly to the consumer after warnings and awareness campaigns had been carried out. That is

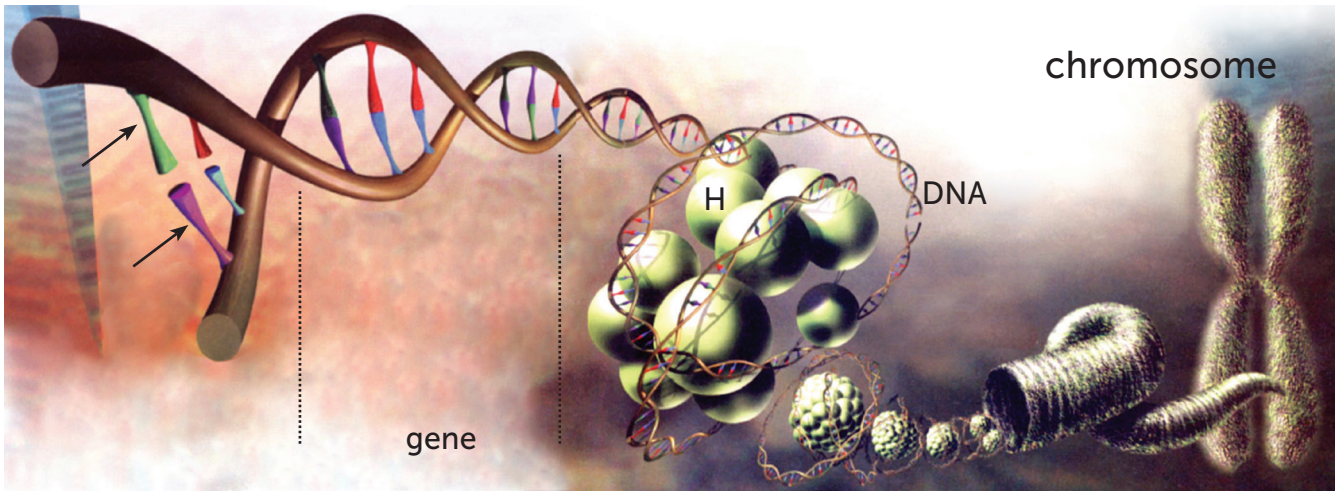


Figure 2 - The 46 chromosomes of each human cell contain 25 thousand genes. Each segment of DNA that represents a piece of information is named gene, with its nitrogenous base (arrows). The initiating agents can change this sequence of bases and promote permanent mutations. The promoting agents potentiate these mutations and break out cell proliferation of these mutated cells, thus, originating a neoplastic cell clone (histone = proteins that sustain the winding of DNA in chromosomes as bobbins).

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how democracy works; products are sold directly to the consumers, but with a wide range of awareness, classification and explanatory campaigns stating that these products are carcinogenic.

As for health professionals, they must neither apply nor recommend carcinogenic products to their patients, unless they have no other therapeutic option and the cost/benefit of using these products has been carefully assessed and discussed with the patient. That is similar to what happens when oncology-chemotherapy, radiotherapy and medical treatments, in addition to other options used for autoimmune diseases, are prescribed.

The choice between the risk of carcinogenic action in the oral mucosa and the benefit of tooth bleaching must be carefully analyzed prior to the use of hydrogen peroxide. Thus, those patients who wish and/or professionals who recommend tooth bleaching procedures must be aware that tooth bleaching products present carcinogenic characteristics that act in the oral mucosa. Only after that professionals should take the preventive measures that are necessary to prevent these products from touching the soft tissues. Resin protective barriers and/or other isolation devices may be used to protect the oral mucosa and prevent the patient from swallowing the tooth bleaching product. Additionally, these barriers/isolation devices are able to protect the tooth cervical region which is so fragile and in which dentin gaps may be present.[2,6,7,8,16]

If patients use tooth bleaching products at home, they are not adequately protected and the contact between hydrogen peroxide and oral, pharyngeal and other gastrointestinal mucosas is inevitable.[2]

When patients use tooth bleaching products at home, they tend to use them for a longer period of time and more often than what has been recommended to them. Using tooth bleaching products at home may "bleach patient's teeth quicker and more intensively", since the procedure is carried out without control and/or any restriction.

However, the ideal teeth whitening procedure must be carried out directly by the professional, and not under his supervision, only. Lay people, such as assistants and patients, are not trained and do not have knowledge or awareness to:

1) Totally remove any product residue with a suction device before the isolation device is removed and afterwards, only afterwards, water patient's mouth.

2) Remove hydrogen peroxide with one tip of the saliva ejector, and eject saliva or water that has been blasted into patient's mouth with another tip or with other ejector. Using the same tip of the ejector makes the tooth bleaching product touch the oral mucosa.

Mouth washing with hydrogen peroxide performed on a daily basis many times a day may seriously harm gastrointestinal mucosas. The potential of tooth bleaching agents to promote carcinogenesis occurs in the entire gastrointestinal tract.[1,17]

MORE INFORMATION ABOUT MOUTH WASHING WITH HYDROGEN PEROXIDE AND TEETH WHITENING

In order to kill bacteria, our cells phagocytize and conglobate them into intracytoplasmic vacuoles (real "balloons" or bags that can be compared to a gas chamber) where powerful substances such as enzymes, chlorine solutions and hydrogen peroxide are thrown. Cells throw these substances only after it is certified that their vacuole walls are preserved — should there be any lesion, the cell dies: hydrogen peroxide and chlorine are lethal. When hydrogen peroxide acts directly on tissues, it is transformed into hydroxyl radicals and superoxides that are extremely toxic and reactive. They produce devastating effects by oxidizing vital components, such as cell membrane and DNA, and may cause mutations.

A long time ago, men discovered that hydrogen peroxide dissolves the remnants of necrotic cells and tissues, which decreases the amount of microorganisms and facilitates antibiotic action. However, hydrogen peroxide must be used in very specific cases, at appropriate concentrations and by properly qualified professionals, as recommended by the Food and Drug Administration (FDA), which classified it as a debriding agent to be temporarily used in the oral cavity.[3,9] A multinational company has recently removed a hydrogen peroxide-based antiseptic from the market, probably because people were inappropriately using it, with regard to location, time and frequency of application.

Chlorine and hydrogen peroxide-based solutions can be found inside cupboards at our homes, but must remain far away from children and animals. Indications for use and cautions must be followed, and the manufacturers must provide a contact number in case of intoxication. They are toxic caustic products that may even lead to one's death if we do not properly follow the instructions for use.

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People using cleaning and hygiene products with hydrogen peroxide and chlorine solutions must wear safety gloves, but many people prefer handling them with unprotected hands and, in general, nothing happens. Our skin has a thick and resistant protection layer: the keratin. This layer cannot be easily penetrated given that it is thicker in hands and teeth than in other parts. The following is among the recommendations of caution and limitation of use for these products: protect oral, genital, nasal, ocular and other mucosas. Mucosas do not have the keratin layer, and when they do, it is very thin.

On the internet, probably due to ignorance about the principles of Chemistry, Cosmetology, Medicine and Dentistry, some people have irresponsibly recommended hydrogen peroxide as a mouthwash capable of decreasing the amount of germs in the mouth and reducing gingival inflammation while cleaning and bleaching the teeth. Those people should be notified and sued by the government for committing a crime against public health and for trespassing the limits of public trust.

Hydrogen peroxide reddens the mucosa and gingiva by wounding them with tissue dissolution and inflammation. Hydrogen peroxide burns and may lead to necrosis of gingival papillae. It completely cleans the teeth because it demineralizes the enamel and also removes dirt or pigments. The enamel becomes porous[2,6] and food stains it even more, increasing the need for mouth washing. Enamel becomes thicker everyday. Should there be any restoration, it will induce microleakage through its interface with the tooth, causing the enamel to come out easily while eating.

If burning the mucosa and demineralizing the enamel were the biggest problems, we could think about using hydrogen peroxide with moderation. However, the biggest problem is that hydrogen peroxide is a promoting agent. In other words: it potentiates the effect of inducers of oral, throat, esophagus, stomach and intestine cancer. Pesticides, tobacco products, alcohol, HPV and other oncogenic viruses, sunray and chemicals found in industrialized food are potentiated by hydrogen peroxide.

Many doctoral dissertations, master's thesis, researches and books confirm what the literature has already proved by means of different methodologies.[1,17] *In vivo* chemical carcinogenesis experiments prove the carcinogenic effect of hydrogen peroxide on the mucosa that receives tooth bleaching products, antiseptics and tooth paste.

In the thesis written by Pieroli,[17] in 1997, at the University of São Paulo (USP), the carcinogenic effect of tooth bleaching products on hamsters was compared to DMBA, a drug that has been especially developed for experiments involving induction of oral and skin cancer. During 22 weeks, it was observed that tooth bleaching products alone were not capable of inducing oral cancer. However, when they were alternately applied with DMBA, the number of animals with cancer and the size of the lesions increased, which suggests that hydrogen peroxide does not initiate, but stimulates the proliferation of cells modified by another carcinogenic agent. When a chemical substance has this property, it is named as "promoter", and it can strongly act in the mouth, since that is where many initiators are.

In his doctoral dissertation written in 1999 at USP, Camargo[1] assessed the carcinogenic effect of hydrogen peroxide-based tooth pastes. Out of 30 brands, 29 had hydrogen peroxide in their formula, including tooth paste for children. However, most of these products did not state on their package the presence of hydrogen peroxide. In the hamsters used for that research, the effect of hydrogen peroxide present in tooth pastes was similar to tooth bleaching products applied alone: it was a carcinogenesis promoter.

Tooth bleaching products are part of the modern culture and we must progress technologically to reduce their undesirable effects. Teeth whitening must be safe and the conscious option of not carrying it out must be respected. Thus, the packages should provide this information, so the consumer has the option of choosing between tooth pastes with or without hydrogen peroxide.

"HOMEMADE" TEETH WHITENING. WHY NOT?!

Does teeth whitening has the same carcinogenic effect at the clinic and at home? No. A qualified professional uses isolation devices, such as a resin cervical barrier or other mechanical/physical devices, to prevent tooth bleaching products from touching the mucosa. Before removing both the tooth bleaching product with water and the resin cervical barrier, the bleaching product must be totally ejected. Only after it has

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been completely removed, the resin cervical barrier or other isolation devices are taken off. At the clinic, the amount of tooth bleaching product that touches the mucosa is very low and occasional. Conversely, during brushing, the product touches the mucosa on a daily basis, similar to what occurs when hydrogen peroxide is used as a mouthwash or when whitening strips are continually used.

Does at-home dental bleaching present higher risks? Yes, because even if patients have been instructed by the professional and the application tray has been properly adapted, patients tend to let dental bleaching product spread in the mouth with their saliva. It will inevitably touch the oral mucosa for a long period of time and its partial ingestion will cause it to reach the gastrointestinal mucosas.

Self-medication is quite frequent and the product may be purchased without the prescription of a professional. For this reason, it is wrongly and carelessly used at home. Lack of control over time and frequency of use may enhance teeth bleaching, but at the expense of biological effects on the mucosa and teeth, which is not worth the risk (unmeasurable in the future). Tooth bleaching products must be considered as medicines, and their use must be restricted to dentists duly trained to carry out the procedure. Unfortunately, they are freely sold and not everyone is aware of their risks.

FINAL CONSIDERATIONS ABOUT MOUTH WASHING WITH HYDROGEN PEROXIDE

All procedures carried out with hydrogen peroxide in the mouth with the purpose of whitening the teeth should be performed directly by a dentist who has been properly trained to prevent the oral mucosa from receiving this product during the procedure. The time and method of use require caution in order to decrease, to the minimum, the undesirable effects of hydrogen peroxide on tooth tissues and restorations. Whitening strips and other tooth bleaching products are all hydrogen peroxide-based.

Should mouth washing with hydrogen peroxide be occasionally done, touching the oral mucosa once a year or every six months, it would cause minor cocarcinogenic effects. However, should it be done everyday or every week, as an antiseptic used to help with oral hygiene, it would become a protocol that is highly reckless to health! Websites, blogs and social network profiles that recommend the procedure should be immediately sued by the government!

Esthetics comprises harmony between shape, size, position and color. If we take a closer look at some people's smile and notice red gingiva and lips with extremely white teeth, the diagnosis of excessive use of hydrogen peroxide is inevitable: artificiality is evident. Extremely white teeth and red gingiva and lips create a quite artificial picture from an esthetic standpoint!

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Importance of the control group in scientific research

Matheus Melo Pithon*

Fundamentally, scientific research aims at contributing to the development of human knowledge in all areas, being systematically planned and executed according to rigorous criteria of information processing.[1] It consists of investigations, observations and experiments, and tries to use these tools to explain the causes of many phenomena.

When reading scientific articles of which purpose is to experiment, we find the so-called control group. What would that be? What is the importance and need of a control group in a scientific study? The objective of the present article is to present, in a clear and objective manner, the importance of including a control group in scientific research.

The control group consists of elements that present exactly the same characteristics of the experimental group, except for the variable applied to the latter.[2] This group of scientific control enables the experimental study of one variable at a time, and it is an essential part of the scientific method. In a controlled experiment, two identical experiments are carried out: in one of them, the treatment or tested factor (experimental group) is applied; whereas in the other group (control), the tested factor is not applied.[2]

A good example for us, orthodontists, is the assessment of the influence of medicine over orthodontic tooth movement. In these cases, it is important to examine if the supposed effects of the applied drug are produced only by the drug. In this situation, identical groups of patients or animals are compared, one of them receives the drug and the other receives a placebo or, in many cases, does not receive any drug (control group). In order to avoid bias, it is always important to prevent not only the researchers, but also the individuals who will receive the medicine from knowing which group receives the real drug.

In Orthodontics, as in any specialty in the Health field, it is difficult to establish a control group for clinical studies, given that many ethical implications are involved. A good example to demonstrate this situation is the proposal of a study focused on the assessment of a new method for skeletal Class II malocclusion treatment of patients in craniofacial growth. The ideal control group, in this case, would comprise patients with the same characteristics of those in the experimental group, including age, race, maturation stage, same tendency for craniofacial growth. However, to be in the control group,

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patients should not be orthopedically treated, precisely in the ideal phase for treatment. In these situations, an ethical issue arises: How can we carry out an experiment without causing any damage to patients? In situations like these, it is acceptable that the patients in the control group be subjected to procedures already established in literature[3] – which, in this particular case, would consist of treatment performed with extraoral appliances (considered as gold standard in the treatment of malocclusion).

Although not ideal, given that we would not have a control group without any involved factor, this approach meets the ethical requirements that currently surround us.

A more delicate situation involves studies that use computed tomography as a method of diagnosis. We are currently experiencing an avalanche of scientific researches using this new technology. Its use has facilitated diagnosis and orthodontic planning, however, when we think about scientific research — and, more precisely, about control groups — , the following question arises: Would we be exposing our patients to unnecessary risks? Considering that by using this tool in a study that contains a control group we would be exposing the patient to two situations: the absence of treatment and the unnecessary exposure to ionizing radiation, we should think about it. Food for thought.

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With joy and trust, I have accepted the invitation to coordinate this interview with professor Dr. Antônio Carlos de Oliveira Ruellas, one of the most renowned men in Brazilian Orthodontics. For those who do not know him, he is from the town of Areado (near the cities of Alfenas and Poços de Caldas) in the state of Minas Gerais. In 1989, he got a degree in Dentistry (School of Pharmacy and Dentistry — Alfenas — EFOA/Unifal) and two years later, under the advice of professor Walter Alves Araújo, he began his career as a professor of Dentistry at the University of Alfenas/Unifenas while he was still in the undergraduate course. Later on, professor Ruellas taught Physics at a university entrance exam preparation course in Alfenas. Subsequently, he went for the masters and doctorate degree in Orthodontics at the Federal University of Rio de Janeiro (UFRJ) where he stood out as one of the best students and, later on, one of the professors of that renowned institution — a position he has skillfully occupied until these days. Professor Ruellas has recently finished his post-doc in Engineering of Metal and Materials at the Military Institute of Engineering (IME). He has published more than 190 articles in national and international periodicals, in addition to two books (his most recent books is entitled "Biomechanics applied to the clinical practice", a masterpiece of the orthodontic literature), among others. Professor Ruellas stands out from the crowd not only for his titles, academic production and attributes, but even more for his simplicity, humbleness and generosity towards those around him. He has always supported his students to go beyond him by saying "My students should be better than I am, and their students should be better than what they are…". At work, he passes on everything he knows, and when he does not know something, he admits it, always seeking more and more knowledge. I consider professor Antônio Carlos as my orthodontic father — I dived into Orthodontics because of his advice and his lessons. I had the privilege of being his student during the undergraduate, postgraduate, masters and doctorate courses. And that makes me very proud. I do not know anyone else who has had the privilege of being his student during all learning stages. I would like to end this preface by inviting everyone to read and enjoy this interview that will certainly expand our orthodontic knowledge.

Matheus Melo Pithon

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

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With regard to vertical Class II skeletal malocclusion treatment during growth, which are the therapeutic options? What are the possibilities of employing skeletal anchorage to control growth in these cases? Is there any scientific evidence and what are the future prospects?
(André Weissheimer)

A successful treatment for a vertical Class II skeletal malocclusion depends on precisely controlling growth direction. I believe that considering whether or not growth direction is predominant due to some habits, such as mouth breathing, plays a major role both in diagnosis and prognosis. This is normally present due to difficulty in lip seal caused by proclination of the upper incisors. Controlling the vertical alveolar growth, especially in the maxilla, will enable mandibular counterclockwise rotation.

When deleterious habits are present, their removal is enough to recover growth direction, at least partially. Additionally, employing mechanics to control vertical alveolar growth will yield satisfactory results. The mechanics that can be used to control vertical alveolar growth are: High-pull headgear, vertical chin cup, mini implant (MI) and miniplates. High-pull headgears, MIs and miniplates require that the applied force be transmitted to the posterior teeth by means of a rigid arch, and that it does not remain restricted to one or two posterior teeth, only. Although being effective, high-pull headgears and vertical chin cups (especially the high-pull headgear) totally depend on patients' cooperation. Nowadays, this requires that the orthodontist be highly persuasive and able to show to the patient not only the importance of using the appliances, but also their consequent benefits. Due to being increasingly rejected by patients, the use of high-pull headgears and vertical chin cups has significantly decreased.

Conversely, MIs and miniplates do not require patients' cooperation (except for the need of specific hygiene for that area). The miniplates probably yield more satisfactory results due to the possibility of providing support outside the alveolar bone area. However, both require the need for surgery, especially the miniplate (for which the intervention of another professional is necessary), which implies higher costs.

The future prospects are that temporary skeletal anchorage will be more used, as costs tend to decrease, stability tends to increase, patients tend to become more aware and familiarized with this type of therapeutic resource and, as a consequence, tend to reject it less.

Although many researches have assessed the use of skeletal anchorage for the Class III treatment,[1-5] additional studies are warranted to further investigate its use for Class II treatment. It is possible that, in a very near future, new findings will be published about this topic.

Treatment of skeletal Class II malocclusion is often associated with tooth extraction in only one or in both arches. What are the requirements that should be taken into account to perform tooth extraction in one or in both arches?
(Matheus Melo Pithon)

Extraction performed in the upper arch is recommended for Class II patients whose mandibular arch is in good conditions (positive discrepancy, little or no negative discrepancy) or in cases of proclination in the mandibular arch, in which the mandibular incisors will be compensated, since repositioning them would lead to overjet, which is normally significant, and for this reason, hinders correction. Thus, extractions in the upper and lower arches are recommended in the following situations:

» Negative lower discrepancy (cephalometric discrepancy + dental discrepancy), from moderate to accentuated value; or mild when associated with one of the factors described below (protruded profile, intensified vertical dimension, lack of lip seal). Extractions allow the creation of space for alignment and leveling of teeth, in addition to favoring passive lip seal due to correction of incisor protrusion.

» Protruded profile: Since facial esthetics is highly valued, extractions should be considered to improve labial protrusion and facial profile esthetics. Should extractions be recommended for other reasons (such as little total discrepancy) or should they worsen facial esthetics, they must be questioned and discussed. Patient's age and ethnicity may also be taken into account. Changes in the facial profile of adult patients may age them; therefore, such changes must be carefully performed. One should also seriously consider obtaining a slightly convex profile for adolescents, since their profile tend to become straight and/or concave with age.

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» Increased vertical dimension: In this case, extraction of lower second premolars may be considered to obtain vertical control and molar occlusion relationship, which would facilitate anchorage loss, especially if mandibular arch discrepancy is mild and changes in facial profile are not absolutely necessary. However, the patient must be advised not to apply excessive force during oral hygiene in order to avoid potentiating recession in the lower first molar mesiobuccal root. Moreover, with this same purpose, the clinician must promote an adequate torque control and lower molar offset for the mesially moving molar (excessive buccal root torque and offset may potentiate gingival recession). Thus, the arch must be adjusted with compensating bends (or by modifying those that already exist).

In my opinion, mass retraction should be carried out in cases in which anteroposterior and vertical anchorage control is not compromised. In other words, during retraction of anterior teeth, both mesial migration of posterior teeth and increase in maxillary incisor exposure at rest are allowed. As a result, the maxillary incisor would be more exposed in relation to the lip, and overbite would increase. Thus, prior to treatment onset, the patient should have slight lip protrusion in relation to the face, little overbite as well as little exposure of the maxillary incisor. However, in most cases, patients do not conform to these features and if they choose to perform mass retraction, both anteroposterior and vertical mechanical control may be compromised and result in gingival smile and increased overbite. The best alternative to perform mass retraction in these situations is doing so by means of mini-implants[6] (Fig 1). A hook is welded to the canine distocervical wing of enough height to allow the elastomeric chain, which pulls the tooth against the mini-implant, to be horizontally placed. This results in canine distal movement and minor intrusion of the upper incisors. The more tipped the elastomeric chain (in the same direction as shown in Fig 1), the greater the incisor intrusion. From the second appointment on to activate the space closure system and replace the elastomeric chains, the teardrop loop is activated by anchoring the distal hook to the loop up to the MI.

Although retraction of canines and incisors will be simultaneously performed with different mechanical controls, they complement each other because incisor intrusion, happening as a result of an appropriately placed canine hook, helps with vertical control of anterior teeth during retraction. The vertical effect (extrusion) of posterior teeth may be suppressed by a steel wire ligature placed from the MI to the arch and anchored between the premolar and the first molar. As for the control of buccolingual tipping of anterior teeth, it is performed by means of torquing bends, if necessary.

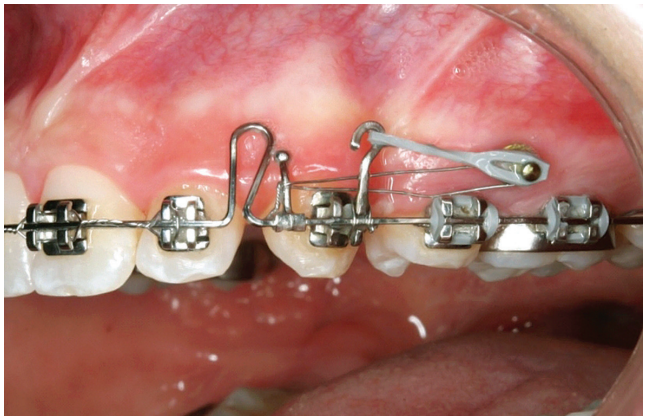


Figure 1 - Photograph showing mass retraction supported by mini-implants.

With regard to treatment of dental Class II malocclusion in adult patients, which are the aspects that should be considered when opting for treatments that comprise extraction of upper first premolars or skeletal anchorage used for distalization? What are the recommendations, limitations, advantages and disadvantages of each treatment option? (André Weissheimer)

Dental Class II malocclusion in adult patients comprises the following options of orthodontic treatment:

a) Distal movement of upper teeth, which may be performed with headgear appliance, intraoral jig appliances, intermaxillary elastics with Class II direction, MIs or miniplates.

b) Upper premolar extractions (PM).

The choice between these two options should be based on the following:

a) Amount of distalization: The greater the need for distalization, the stronger the decision leans towards extraction of PM. In my opinion, distalization must not be greater than 3 mm, i.e., not greater than half of the PM mesiodistal width. Except for cases in which the vertical dimension of the facial lower third has decreased.

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b) Vertical dimension (VD): Increased VD, difficulty with lip seal, increased lower facial third and decreased overbite are some of the aspects one should take into account when planning treatment that involves extraction of upper PM. The same aspects, but in opposite conditions, tend to direct treatment towards distalization.

c) Presence of third molars: In the presence of fully formed third molars, I tend to recommend extraction of PM because it is probable that, as a result, there will be enough space for eruption of the third molar — which, without extraction of PM, probably would not occur. The patient would have the same number of teeth in the oral cavity and both of them are dental organs. Treatment would be quicker and would involve fewer risks (there would be little need for tooth movement). Additionally, the chances of replanning and changing the procedures would decrease (should distalization be ineffective or the MI be unstable). In cases in which distalization is considered, I usually recommend extraction of the third molar, depending on its position and the space available in the posterior region (given that two bodies cannot occupy the same space at once).

d) Maxillary tuberosity bone: When distal movement is planned, it is necessary to assess the amount of bone present in the maxillary tuberosity. Is there bone so that teeth may be distally moved? Should there not be enough bone, I recommend extraction of PM.

e) Cooperation: Adequately cleaning the MI is essential to maintain its stability and may influence on the treatment success performed with distalization supported by the MIs. This aspect will be even more critical if the treatment choice involves a headgear appliance or intermaxillary elastics with Class II direction.

f) Second molar tipping: At first, during eruption, this tooth is distally tipped. This tipping is corrected as the tooth erupts and the tuberosity grows. Distal tipping of second molars usually represents lack of space in the posterior region (lack of bone or presence of the third molar which hinders uprighting of the second molar). Thus, extraction of upper PMs is recommended.

g) Retreatment: This planning must be objective and precise. Therefore, if distalization has already been attempted and yielded unsuccessful results, I suggest that this procedure be avoided.

These items work as guides, since assessment does not depend on the number of pros or cons against a decision, only, but on the importance each item has over the decision of planning each case individually. It is worth noting that professional clinical experience is of paramount importance for all kinds of orthodontic planning, since it allows the professional to easily visualize solutions and identify alternatives. That is the reason why I usually assert that all health professionals should go through a training period (in my opinion, for five years) after they finish their specialization course, or that they had a "tutor" (someone with more experience, who would work as their "advisor", helping them on their planning). Well-structured courses and committed students lead to excellent technical-scientific preparation of recently graduated professionals, but clinical experience cannot be totally passed on.

Class II malocclusion at the end of the mixed dentition, near pubertal growth spurt, is traditionally treated with headgear appliances. Do you believe it is possible to treat Class II malocclusion with mini-implants? Are you aware of any scientific research by which both methods are compared? (Márlio Vinícius de Oliveira)

Studies assessing treatment of Class III performed with skeletal anchorage have been well reported in previous articles.[2,7] However, the same has not happened with Class II treatment. I do not believe that mini-implants can be considered an appropriate anchorage procedure employed to control anteroposterior growth in the Class II treatment. I believe that miniplates are more successful in the Class II treatment, especially in the vertical control of alveolar growth, given that it allows mandibular counterclockwise rotation and, as a result, better spacial positioning in the anteroposterior direction, which decreases the ANB angle and improves facial profile esthetics. As for the mini-implants,[8-13] I believe they are limited in working as a support for distal movements or as anchorage in cases of premolar extractions for, correcting dental Class II or compensating skeletal Class II malocclusions. I consider that even severe Class II corrections with good facial growth pattern can be easily obtained with functional appliances (high-pull headgear, Herbst appliance) provided that their indications and characteristics have been correctly examined. The biggest problem consists

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in correcting Class II malocclusions with adverse growth pattern (vertical displacement), in which case the MIs[14] and especially the miniplates will yield good results, thus, substituting the extraoral appliances (currently, the best tool that provides the best mechanical control in these cases).

With regard to Class II treatment, what is the age limit to use fixed functional appliances, such as the Herbst and others?

(Luiz Gonzaga Gandini Júnior)

Functional appliances to control bone displacement from facial growth, and consequently correct a Class II, are mostly recommended during the growth spurt phase. Thus, they would be recommended for girls not older than 13 years old, and for boys not older than 14 years old. Using these appliances at a subsequent age will produce mainly dental effects, with correction by compensation and stability that depends on the patient's initial features (lower incisor buccolingual tipping, mandibular plane tipping, vertical dimension, lip seal, mandibular muscle tone). One should also consider potential effects of fixed functional appliances on TMJ (especially on the retrodiscal ligaments, articular disc and capsule), mainly in adult patients whose capacity of adaptation is limited. Some researchers have assessed the effects of using the Herbst appliance in adults,[21-24] and have concluded that dental effects tend to be more prevalent as the patient gets older:[21] In my opinion, it should not be used in adult patients and treatment should not be finished with the mandible more anteriorly positioned in relation to the articular cavity.[25]

Given the great diversity of biomechanical systems, which force system do you prefer to use to upright mesially tipped lower molars in cases of space closure (mesial movement of the root) — with and without vertical control, taking into account simplicity, patient's comfort, clinical efficiency and predictability of results?

(André Weissheimer)

I believe that the best system used to upright lower molars that have been tipped due to loss of mesially positioned teeth comprises MIs, especially when the MIs can be distally positioned in relation to the molar that will be uprighted.[6] Such position allows better vertical control of molars, but is recommended in cases in which space will be opened through distal movement of the crown and posterior rehabilitation of the edentulous space. Uprighting through mesial movement of the root is more difficult to be performed due to the great amount of bone that will have to be reabsorbed in the region mesial to the root. Mesial movement of the root without vertical control can be achieved with an uprighting spring with the support of a segmented arch or a MI (Figs 2A and B). Absence of vertical control is sometimes recommended, especially when the purpose is to gain vertical dimension of the lower facial third for later rehabilitation. It is worth noting that it is necessary to keep adequate free functional space. Vertical control should be associated with some other tool in order to intrude the molar during uprighting, thus, preventing the molar crown from occupying a more "extruded" position.

As for uprighting of molars, what are the parameters used to choose between segmented mechanics and straight archwires? When are Temporary Anchorage Devices (TAD) used, what is the determining factor of such a choice?

(Luiz Gonzaga Gandini Júnior)

I consider the vertical aspect as one of the determining factors when choosing between segmented mechanics and straight archwires to upright lower molars. That is because straight archwires allow greater extrusion of the mid segment of the arch in comparison to segmented arches. Additionally, controlling the buccolingual position of the mesially positioned tooth towards the edentulous space is safer when performed with segmented arches. In general, the second premolar must be leveled to the mesially positioned dentition by an rigid arch. Thus, I believe that in most cases (except for mild tippings) the segmented arch mechanics should be used for this purpose. In cases of space closure, I suggest that — should there be any space left to be closed after complete uprighting carried out through mesial movement of the root — it be performed with straight archwire, from this point on.

I recommend that uprighting be, as much as possible, supported by TAD, only (with the segmented arch going from the TAD to the tooth that will be uprighted), in order to prevent side effects on the dentition (extrusion, transversal movements, anteroposterior movements). The greater the initial tipping of the

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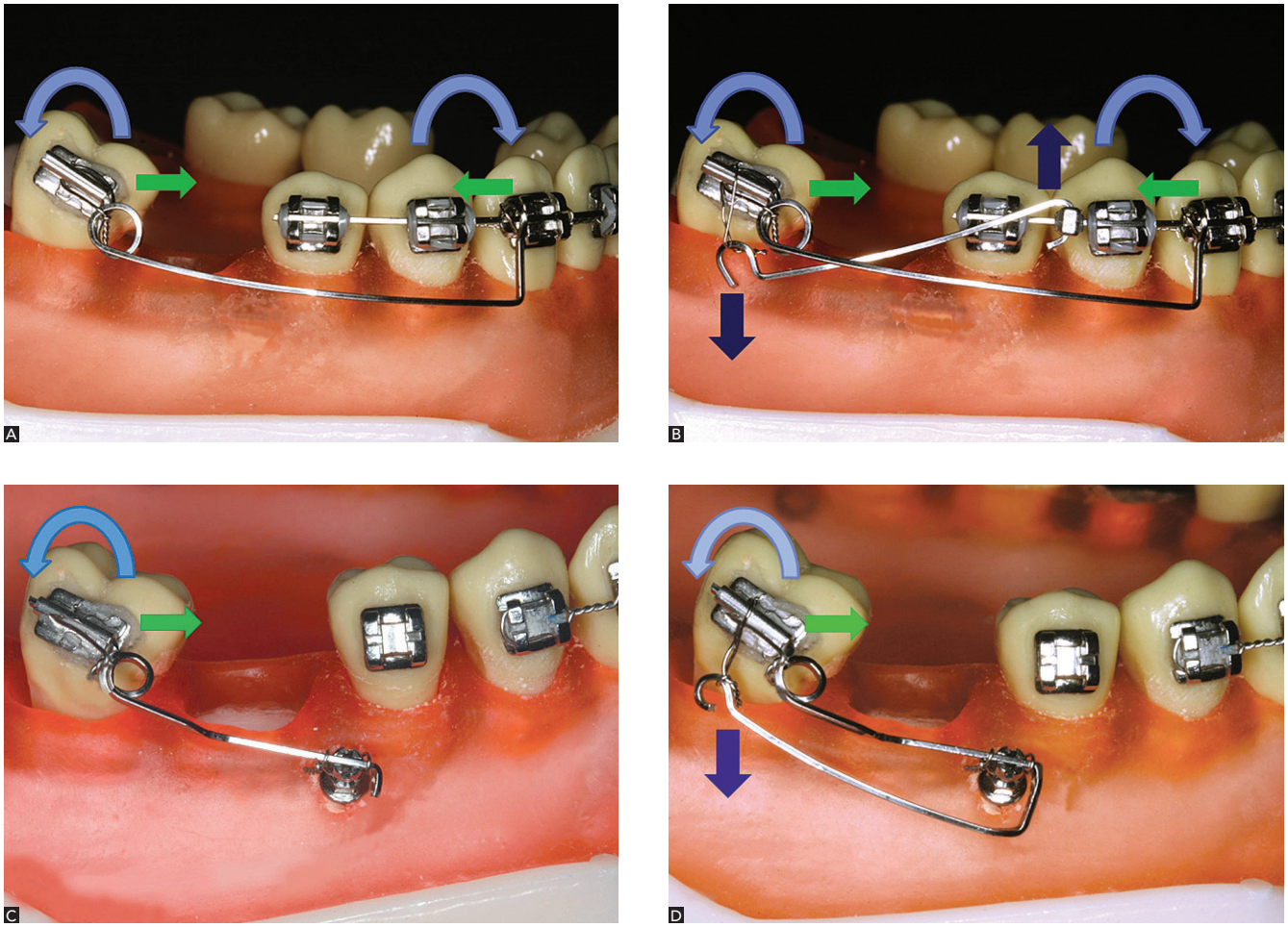


Figure 2 - Molar uprighting through mesial movement of the root, without vertical control. **A, B**) without MI support; **C, D**) with MI support; **A, C**) without vertical control; **B, D**) with vertical control. The uprighting spring must have its helicoidal surface attached to the tube in all options. In **A** and **B**, the mesial portion of the spring, which is fitted between the premolar and the canine, is mesially inserted into the bracket of the canine; avoiding distal movement of the molar crown. In **C** and **D**, the mesial portion of the spring is fitted in the MI and must end close to the MI, avoiding distal movement of the molar crown. After the molar has been uprighted, I recommend that the spring be replaced by a loopless straight archwire and that the molar be mesially pulled (especially by buccolingual inclination, avoiding rotation) with mild force, in a 0.018 x 0.025-in archwire, avoiding new mesial inclination, with or without MI support.

molar that will be uprighted and the space that needs to be closed (if applicable), the greater the need to use TAD. MI is the most used tool for these cases. Should the MI be distally positioned towards the molar that will be uprighted, vertical control will be more effective. However, should it be mesially positioned, vertical control will be hindered. Depending on the clinical case, even if TAD is used, molar vertical control may not be as effective. Extrusion will be limited to the molar, only, in which case occlusal adjustments or rehab treatments may be performed (if necessary).

The current stage of development of mini-implants allows us to treat complex malocclusions which, not long time ago, were treated by means of orthognathic surgery, only. Have you used this mechanism to treat anterior open bite, for example? What is the mechanical planning (number and positioning of mini-implants) most widely used for this purpose?

(Márlio Vinícius de Oliveira)

MIs have considerably helped orthodontic treatments and, in many open bite cases, they may eliminate the need for orthognathic surgery, provided that the MIs present satisfactory stability during treatment. In some cases, it is possible to eliminate the need for orthognathic surgery by correcting the skeletal problem (especially when growth is still ongoing) or treatment by compensation (without correction of the skeletal problem, but by obtaining compensatory dental positions that disguise it). In other cases, the need for orthognathic surgery may be minimized: Involving only one arch, for example, whereas when MIs are not used, both arches are involved.

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Figure 3 - Photograph showing intrusion of posterior teeth with MI support.[6]

Initially, I use the MIs in the arch where the posterior teeth have bigger clinical crowns (longer in the cervico-occlusal direction) and, afterwards, in the other arch, if necessary. For intrusion of posterior teeth in open bite correction, I use at least two mini-implants on each quadrant because either intrusion or vertical growth control will be necessary (depending on the patient's stage of development) in more than one tooth, thus, allowing greater support. Then, I apply elastomeric chains that go from the MIs to the rigid arch inserted into the brackets; or I use a segment of wire in both MIs (bracket head), which allows traction to be exerted in different points of the wire fixed to the brackets[6] and in the segment of wire inserted into the MIs (Fig 3). In terms of position, I believe that a MI should be placed between premolars, while the other should be between first and second molars. However, due to difficulty in placing a MI between molars, I often place it between the premolar and molar. If the purpose is to achieve rotation of the occlusal plane (extrusion of incisors), straight wire mechanics may be used. If the effect in the incisors must be totally neutralized, intrusive force with the support of a segmented arch should be applied, acting on posterior teeth, only. After improvements in leveling the occlusal plane have been achieved, treatment begins to be performed with a straight wire.

It is worth noting that mechanics should be associated with recovery of patient's normal functions, especially nasal breathing and lip sealing, which are essential to reestablish normal growth conditions and correction stability.

Based on your professional experience, which factors are determining when choosing between intermaxillary elastics, tooth extraction, mini-implants, miniplates and orthognathic surgery to treat open bite?

(Luiz Gonzaga Gandini Júnior)

I believe that orthognathic surgery is restricted to two situations: Functional and/or esthetic limitation. In other words, if a key function cannot be obtained without surgery and/or if the patient is not satisfied with his facial esthetics due to the malocclusion, orthosurgical treatment is recommended. Otherwise, orthodontic treatment should be carried out, or at least tried to be performed. Miniplates and mini-implants are recommended to intrude posterior teeth (or to control vertical alveolar growth) and to reduce or control vertical dimension of the lower third of the face. The same applies to extractions, especially if the need for vertical control is associated with the need for space gain in the arch (distalization would lead to increased vertical dimension, and proclination of anterior teeth would lead to decreased overbite). Extractions with predominant mesial movement of posterior teeth can decrease vertical dimension. Thus, in case of extractions, we usually recommend extraction of second premolars, first or even second molars. Intermaxillary elastics are recommended for cases in which the vertical dimension is normal and the patient's features allow extrusion of incisors. That is to say, exposure of upper incisors at rest is decreased, or a minor increase in exposure of upper incisors, if normal, does not compromise facial esthetics and will not result in gingival smile. Such consideration regarding exposure of upper incisors must be taken into account according to patient's age, sex and upper lip length.

I believe that associating two or more of these procedures, whenever recommended and possible, is useful and will result in a more successful and stable correction. They are indispensable not only to recover muscle and respiratory functions (lips, tongue and muscles of mastication), but also for correction and stability. I also believe that associating spurs or cribs to control lingual interference is beneficial.

In cases of deep overbite, what are the parameters you choose when opting between anterior intrusion, posterior extrusion or a combination

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of both? In terms of mechanics, how do you work in each situation?

(Luiz Gonzaga Gandini Júnior)

At first, diagnosis is carried out by measuring the facial thirds. Should the lower third of the face have been decreased, deep overbite must be corrected by extruding posterior teeth. To diagnose the necessary amount of extrusion, the dentist places a wax roller between the occlusal surface of the posterior teeth, asking the patient to press it firmly until the facial thirds are proportional (measurements can be carried out by means of a pachymeter or a compass). The amount of interposed wax corresponds to the amount of necessary extrusion (Fig 4).

If the lower third of the face is proportional or if the deep overbite could not be totally corrected even after the interposed wax had been placed between the posterior teeth, complementary correction will be performed by intruding lower and/or upper anterior teeth. The need for intrusion of anterior superior teeth is examined by the amount of maxillary incisor exposure in relation to the upper lip at rest (half-open lips) and also by taking normal lip length into account (on average, 21 mm). Normal exposure ranges from 2 to 4 mm for young men and from 3 to 5 mm for young women, and it decreases with age. Should exposure increase, intrusion of upper incisors must be carried out. Should exposure be normal or the upper incisor be normally exposed after intrusion, the lower incisors must be intruded. Intrusion of the upper incisor must be carefully carried out. Additionally, it is preferable that intrusion of the lower incisor be performed, especially in adult patients, since intrusion of upper incisors decreases exposure and ends up aging the patient when it is not correctly carried out.

Mechanically, the following options may be used to correct deep overbite:

a) Relative intrusion (relative extrusion) with straight wires, making use of mechanical procedures to avoid proclination of incisors, when it cannot occur.

b) Intrusion of incisors with Ricketts intrusion arch (when the first molar is mesially tipped, vertically positioned or retroclined, favorable growth pattern) or with Burstone intrusion arch (it allows better vertical control due to leveling by segment and stabilizing the posterior segments with segmented arch associated with palatal bar or lingual arch).

c) Extrusion of posterior teeth carried out by means of bite plate, fixed stops attached to the lingual surface of upper incisors, vertical elastics in the posterior region, accessory appliances (when necessary) which also potentiates posterior extrusion (cervical traction headgear, for example). Not only freeway space must be considered for extrusion of posterior teeth (after extrusion, at least 3 mm of freeway space must remain), but also some kind of physiotherapy that is performed to relax the elevator masticatory muscles and, thus, avoid potential relapse.

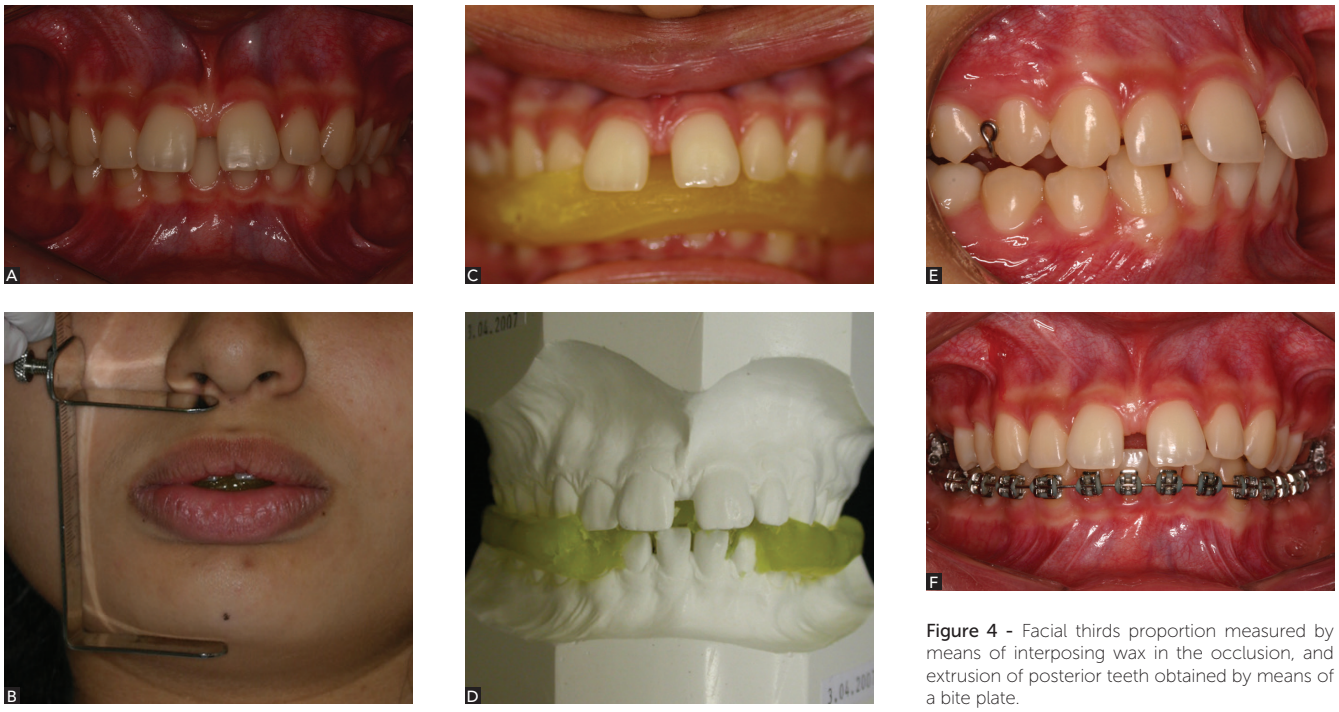


Figure 4 - Facial thirds proportion measured by means of interposing wax in the occlusion, and extrusion of posterior teeth obtained by means of a bite plate.

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As time goes by, orthodontic treatment performed in adult patients has increased exponentially. However, it is widely known that treatment performed in those patients requires considerable caution — especially due to dental absence, restored teeth or loss of periodontal support. From a biomechanical standpoint, which precautions must be considered when performing orthodontic treatment in adult patients? (Matheus Melo Pithon)

Adult patients often present bone loss. In these cases, the center of resistance apically migrates, increasing its distance with regard to the location where force is applied (bracket). As a consequence, mechanical control in tipping movements will be hindered. A possible solution is to place the accessory in a more cervical direction in relation to the center of the clinical crown. Applying mild force will also help to prevent the arch from being deformed, especially in areas of extraction space, thus, minimizing tooth tipping. As for movement of incisors retraction, resistant torque usually needs to be increased for adequate control.

Due to greater bone density, application of mild force and a four-week interval between activations are recommended.

Frequent gingival recession, with little attached gingiva, also result in the need for careful mechanics — especially with regard to expansion or proclination movements, be it intentional or side effects of certain mechanics. For instance, when a spring is used for molar uprighting (Fig 2A), an intrusive effect will be generated in the upper premolars region, and this intrusive force will be inclined in relation to the center of resistance of these supporting teeth: Thus, they tend to be uprighted. Should a segmented arch be associated with it, from premolar to premolar, and present some expansion or inadequate torque, or should the uprighting spring not be contoured — following the curvature of the arch in an anterior direction —, premolars tend to expand laterally. In the region underlying the edentulous space, the presence of little attached gingiva is common, which may lead to total gingival loss if these variables are not controlled.

In order to obtain stability and occlusal balance in adult patients with many restorations, some occlusal adjustments and/or rehabilitation procedures are also necessary, since they adapt the occlusal condition to the new intercuspation that has been obtained.

Increase in the number of adult patients seeking orthodontic treatment leads to an increase in the demand for esthetic appliances. What is the stage of development of esthetic orthodontic archwires? Can they replace metal archwires in all stages of orthodontic treatment, even in more complex cases, such as those involving tooth extractions? (Márlio V. Oliveira)

There is no doubt that the esthetic aspect of orthodontic appliances has become a major concern in the last few years. Even though many options of esthetic archwires are available in the market, I believe they have not followed the development of ceramic brackets, with regard to appearance, color and esthetic layer stability or physical properties. The esthetic archwires currently produced are either archwires made of composite material (a polymer strengthened by glass fiber — fiber reinforced plastic, FRP, archwires) or metal archwires (made of steel or nickel-titanium, covered by a surface made of epoxy resin or polytetrafluoroethylene-based material, which is similar in color to the teeth). The FRP archwires are more esthetic, but cause more severe damage to the physical properties. Even though coated metal archwires present differences in physical properties (in comparison to non-coated archwires),[15,16] they are not esthetically favorable. In other words, they do not "mingle" with the bracket and the tooth (they cannot be disguised). Additionally, they are not stable enough for maintenance of the coating material,[17] which affects esthetics and may result in greater dental plaque accumulation.

Another important aspect worth noting is the friction in sliding mechanics, because the coating material has greater friction than metal, and when the coating material detaches, two problems may occur: Even greater friction due to irregularities caused by material detaching or due to irregularities caused by exposure of roughened metal archwire (some commercial brands have the metal surface treated so that the coating material can adhere to it more easily). This may compromise the characteristics related to: Corrosion, friction, esthetics, physical properties and colonization of microorganisms.

It is worth noting that esthetic archwires are under development — as it happened to other orthodontic materials in the past — and they will probably have good conditions for routine clinical application.

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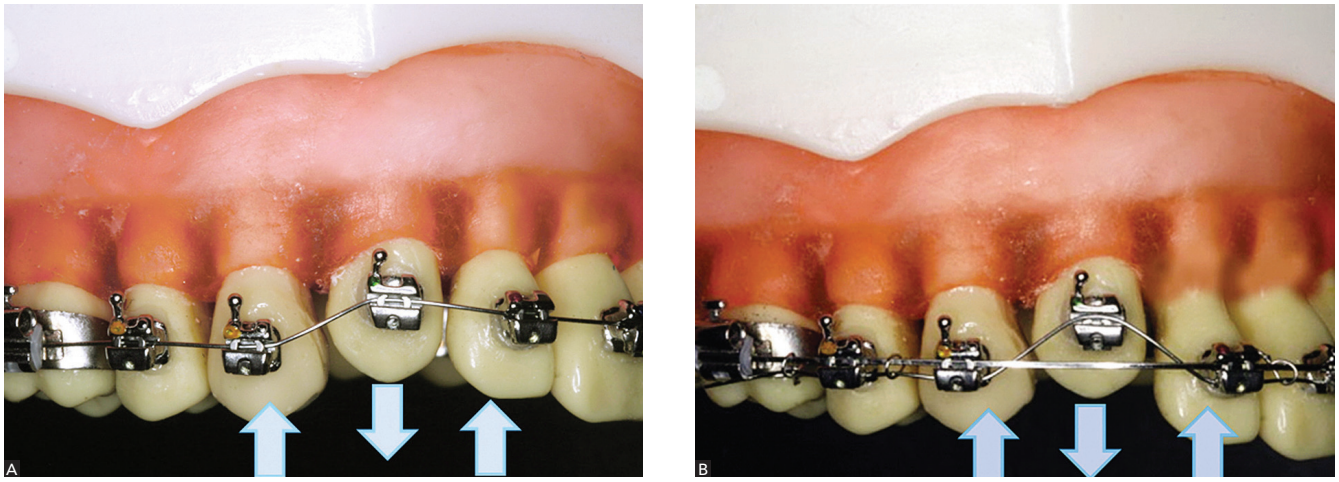


Figure 5 - Traction of tooth with self-ligating brackets. **A**) With NiTi archwire attached to all teeth. Deleterious effects on adjacent teeth (intrusion and buccal inclination, especially in the lateral incisor); **B**) procedure carried out to minimize deleterious effects on adjacent teeth supported by an rigid arch (the intrusive effects on adjacent teeth exist, but do not result in effect on the teeth due to the use of the rigid arch).

Thus, I have currently recommended them mainly for social events (for a weekend, for example) after which they must be replaced by metal archwires again. But I believe that not only patients, but also clinicians wait anxiously for their development and their better characteristics so that they can be clinically used.

Nowadays, we often hear about self-ligating appliances and their innumerable advantages. The materials industry and some researches give to this kind of device advantages such as decrease in discomfort after activation, less friction, shorter chair time and shorter treatment time. Based on your extensive experience in orthodontic biomechanics, biology of tooth movement and properties of orthodontic materials, I would like to ask you: Is it possible to gain so many benefits from these devices, simply due to the fact that they have a different mechanism that entraps the orthodontic archwire? (Matheus Melo Pithon)

I believe and trust in the new technologies that have been introduced into the orthodontic market. The technological development has been a remarkable characteristic of Orthodontics, not only in terms of diagnosis, but also in terms of treatment. Many technologies have been launched. Some of them have been forgotten, but other remained in the market and had their clinical applicability confirmed within biological limits. There is no doubt that self-ligating brackets have some significant advantages, especially with regard to easiness in bonding, which results in shorter chair time. However, tooth movement is a biological response to the application of force and the bracket functions as to transmit such force to the tooth. Thus, the side effects of some kind of mechanics will not be neutralized by the fact that the bracket is self-ligating, only. Discomfort, movement rate and treatment time will not be affected either, no matter the brand of the bracket (considering that all brackets are bonded to the dental surface during treatment and that the space between the archwire and the bracket is the same). High-quality accessories — with better finishing, which are resistant to corrosion and have more precise slot dimensions — certainly present better mechanical response and fewer risks of allergic reactions. However, being self-ligating will not transmit force to the tooth in a more or less favorable mechanical direction, with a higher or lower degree of force. Additionally, it will not neutralize the side effects of a mechanics that is used incorrectly (Fig 5). Some researches reveal no significant difference in terms of response to tooth movement when self-ligating brackets are compared to the conventional ones.[18,19,20]

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Surface morphology changes of acrylic resins during finishing and polishing phases

Glaucio Serra[1], Liliane Siqueira de Morais[2], Carlos Nelson Elias[3]

Introduction: The finishing and polishing phases are essential to improve smoothness and shining on the surface of acrylic resins used to make removable orthodontic appliances. A good surface finishing reduces roughness, which facilitates hygiene, prevents staining and provides greater comfort to the patients.

Objective: The aim of this paper was to analyze the changes on surface morphology of acrylic resins during finishing and polishing phases.

Methods: Thirty discs (10 mm in diameter and 5 mm in length) were made with acrylic resin and randomly divided into ten groups. The control group did not receive any treatment while the other groups received gradual finishing and polishing. The last group received the entire finishing and polishing procedures. Surface morphology was qualitatively analyzed through scanning electron microscopy and quantitatively analyzed through a laser profilometer test.

Results: The acrylic resin surfaces without treatment showed bubbles which were not observed in the subsequent phases. Wearing out with multilaminated burs, finishing with wood sandpaper and finishing with water sandpaper resulted in surfaces with decreasing irregularities. The surfaces that were polished with pumice and with low abrasive liquids showed high superficial smoothness.

Conclusion: Highly smooth acrylic resin surfaces can be obtained after mechanical finishing and polishing performed with multilaminated burs, wood sandpaper, water sandpaper, pumice and low abrasive liquids.

Keywords: Acrylic resins. Scanning electron microscopy. Surface properties.

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INTRODUCTION

Orthodontic appliances are used on upper and lower dental arches with the purpose of preventing, intercepting, correcting or retaining orthodontic issues.[6,11] A wide variety of appliances are proposed, either fixed or removable, in accordance with the main purpose of the treatment. As examples we can mention: expansion appliances to correct crossbites,[6,4] facial masks to correct maxillary retrognatism,[3] removable appliances with Hawley clasp for retaining,[18] space retrievers and space maintainers, fixed inclined plane to correct dental crossbite,[9] among others.

The first step towards making a removable orthodontic appliance is the molding and production of working casts, on which the retention claps are made. The working casts are isolated with vaseline and acrylization takes place. Self-curing acrylic resin is applied to the casts by means of the Nealon technique (powder and liquid) with thickness greater than the desired, enabling finishing and polishing procedures to take place by means of wearing out procedures.[9]

A wide variety of finishing and polishing techniques have been proposed, [2,13] either by conventional mechanical procedures or by chemical procedures which consist in immersion in a monomer-based polishing liquid.

Chemically polishing acrylic resins produces a smooth and shiny surface.[8] However, it reduces mechanical resistance when compared with mechanical polishing, since it adversely affects resin resistance and structure, increasing the chances of deformation.[11]

In mechanical polishing, multilaminated burs are used to remove excess acrylic, to give shape and to smooth the surface. Finishing starts with 150, 180, and 220 wood sandpaper, free of water, with the purpose of obtaining a surface as flat as possible. Afterwards, 400, 600, and 1200 water sandpaper, under a small flood of water, is used until a uniform surface can be seen, without the marks left by wood sandpaper. Polishing is performed with a cotton wheel and a mix of pumice and water. This phase is accomplished when a flat, polished, and shiny surface is seen, without the marks left by water sandpaper. To eliminate the pumice, the appliance is cleaned and dried. The final polishing of the appliance is performed with a woolen wheel and low abrasive liquids for metal polishing (Brasso or Kaol). The appliance is cleaned with soap and water, and dried with paper.[9]

Polishing is important to facilitate the hygiene of the appliance, to hinder the incorporation of pigments or other substances originating from oral fluids,[9] and to improve appliance esthetics and longevity. Furthermore, surface smoothness provides comfort to the patient who is wearing the appliance. Inappropriate finishing and polishing, polymeric surface and physicochemical properties of the material can influence plaque retention and staining, favoring the onset of periodontal diseases and cavities.[13,15]

Radford et al[12] assessed adhesion of fungus in rough acrylic resins and found higher adhesion in rough surfaces than in smooth surfaces. There is a correlation between the number of fungus per unit of area and the wettability, in other words, the more hydrophobic the surface is, the less cellular adhesion it will have. Surfaces that promote the development of dental plaque should be worked out at the laboratory to produce polished surfaces. This will reduce bacterial adhesion and colonization.

Materials used to make removable orthodontic appliances have their esthetic, physical, and mechanical properties degraded after remaining in the oral cavity. Acrylic resins are prone to sorption, a process of absorption and adsorption of liquids, which depends on environmental conditions. The material stains with time due to its contact with drinks, food and nicotine. Beverages such as tea, coffee, Coke, juices, and wine significantly promote the development of stains in dental materials, and so does nicotine. Keyf and Etikan[7] assessed the changes on polished and unpolished resins in contact with a wide variety of drinks and observed change in brightness of all samples, with major changes being observed in unpolished surfaces.

Reis et al[13] observed that the susceptibility of staining in acrylic resins is not only related to surface roughness, but also to intrinsic factors (staining of the bulk of resin) and extrinsic (adsorption and absorption of pigment of exogenous sources). Low susceptibility to staining is related to low range of water adsorption after finishing and polishing.

Finishing and polishing procedures aim at obtaining a smooth and shiny surface for acrylic resins used to make orthodontic appliances,[2] thus, facilitating hygiene, preventing staining and providing greater comfort to the patient. The purpose of this study was to analyze the surface morphology[19] of acrylic resins in each step of mechanical finishing and polishing.

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MATERIAL AND METHODS

Rings 10 mm in diameter and 5 mm in length were made of stainless steel bands. The stainless steel rings were placed over a glass plate isolated with solid vaseline. Self-curing acrylic resin (powder and liquid) (Clássico, Sao Paulo) was manipulated in the proportion described by the manufacturer, poured into the rings where it remained for 20 minutes until polymerization took place. The resin discs were removed from the rings and randomly divided into 10 groups of 3, totalizing 30 samples.

The upper face of each sample was treated as described below. The control group did not receive any treatment while the Kaol group received the entire finishing and polishing treatment. The other groups were submitted to subsequent steps of finishing and polishing, as stated in Table 1.

The wearing out phase was performed with multilaminated burs, by which 1 mm of resin was removed. Sanding was performed with up-and-down movements, repeated 100 times, and the direction of sanding was changed in 90 degrees every time a sandpaper was replaced. Wood sandpaper polishing was performed without water, while water paper polishing was performed under refrigeration of a small flood of water. At the end of each step, the samples were cleaned with water to remove any particles of the sandpaper used in the previous phase. Polishing performed with pumice and water was carried out with a woolen wheel for 15 seconds. The discs were cleaned, dried and polished with low abrasive liquids for metal polishing (Kaol) in a woolen disc for 10 seconds. At the end of all steps, the samples were washed with soap and dried with paper.

The superficial roughness of the samples was analyzed under the parameters Ra, Rq, and Rz in micrometers (μm). This scale translated the value of linear means of all absolute distances of the roughness profile from the central line (L) to the extension of measurement. After that, the samples were metallized and the surface morphology was analyzed through scanning electron microscopy with secondary electrons image.

RESULTS

The untreated discs of acrylic resin showed surfaces with bubbles (Fig. 1A) which were not observed after the wearing out phase performed with multilaminated burs (Fig 1B). Finishing with wood sandpaper resulted in surfaces with irregularities (Figs 1C, 1D and 1E) which remained the same, but with low thickness, after finishing with water sandpaper (Figs 1F, 1G and 1H). The acrylic resin surfaces polished with pumice and water had significantly alterations in their morphology, showing high surface smoothness (Fig 1I). This characteristic was also observed, but in low magnitude, after polishing with low abrasive liquids (Kaol) (Fig 1J).

The alterations in surface roughness were compatible with the quantitative assessment, hence, they significantly decreased during finishing and polishing procedures of acrylic resins (Table 2). The first step of finishing performed with multilaminated burs, resulted in regular deformities, increasing the values of surface roughness. The sequence of sandpapers and the pumice gradually decreased the values of surface roughness. Final polishing performed with low abrasive liquids caused the surface to be even smoother, however, it is considered less effective than the previous steps.

Table 1 - Treatments performed with each group.

Group	n	Finishing and polishing phases
Control	3	No finishing/polishing
Burs	3	Wearing out with multilaminated burs
150	3	Finishing with wood sandpaper 150
180	3	Finishing with wood sandpaper 180
220	3	Finishing with wood sandpaper 220
400	3	Finishing with water sandpaper 400
600	3	Finishing with water sandpaper 600
1200	3	Finishing with water sandpaper 1200
Pumice	3	Polishing with pumice + water
Kaol	3	Polishing with Kaol

Table 2 - Surface roughness at finishing and polishing phases.

Group	Ra	Rq	Rz
Control	1.25 μm	1.57 μm	7.63 μm
Burs	1.52 μm	1.90 μm	8.99 μm
150	1.33 μm	1.72 μm	8.72 μm
180	1.03 μm	1.32 μm	6.31 μm
220	0.85 μm	1.44 μm	6.05 μm
400	0.60 μm	0.90 μm	4.10 μm
600	0.48 μm	0.65 μm	3.12 μm
1200	0.42 μm	0.53 μm	2.81 μm
Pumice	0.28 μm	0.36 μm	1.97 μm
Kaol	0.25 μm	0.34 μm	1.92 μm

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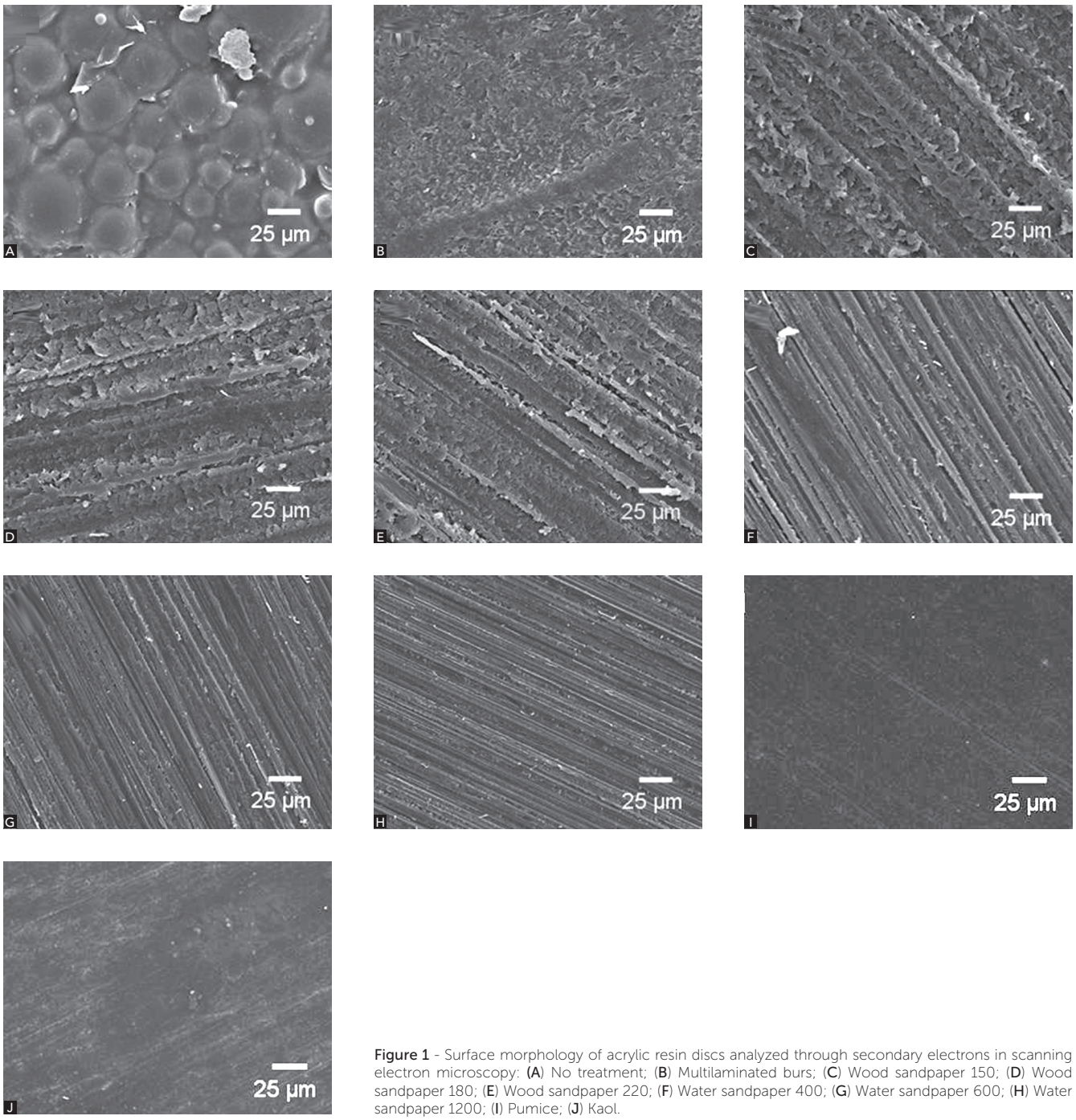


Figure 1 - Surface morphology of acrylic resin discs analyzed through secondary electrons in scanning electron microscopy: (**A**) No treatment; (**B**) Multilaminated burs; (**C**) Wood sandpaper 150; (**D**) Wood sandpaper 180; (**E**) Wood sandpaper 220; (**F**) Water sandpaper 400; (**G**) Water sandpaper 600; (**H**) Water sandpaper 1200; (**I**) Pumice; (**J**) Kaol.

DISCUSSION

According to Adams,[1] the heat-curing and self-curing acrylic resins are used to make removable orthodontic appliances. With the use of self-curing acrylic resins it is possible to easily repair and adjust orthodontic appliances, however, these resins have low staining resistance. On the other hand, making orthodontic appliances with heat-cured acrylic resins in laboratory is complex and time-consuming.[9] Staining and accumulation of dental plaque are directly related to surface roughness.[12,13,16,20] Thus, a smooth and polished surface is desirable.

The results of this work showed that finishing and polishing procedures resulted in roughness-free surfaces. These findings corroborate those found by Chung[5] who analyzed the effects of finishing and polishing on roughness of composite resins and concluded that these procedures decreased surface roughness. The tendency in Orthodontics, as in other areas, is to simplify the

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technical procedures in a way that the aims are achieved with least effort.[14] However, highly smooth acrylic resins surfaces are obtained after complete mechanical finishing and polishing, only.

Multilaminated burs are used during mechanical polishing to remove excess acrylic, give shape and smooth the surface of the appliance.[11] After this phase was completed, it could be observed that the surface of the resin showed many irregularities. Finishing starts with wood sandpaper used with the purpose of making the surface as smooth as possible.[10] In this phase, the acrylic surface is still irregular, with evident grooves. After that, water sandpapers are used, until a uniform surface is seen, without the marks left by the wood sandpaper.[10] This procedure results in a surface with fewer irregularities than the ones previously seen. The next step is polishing with woolen discs and pumice until a smooth and polished surface is seen, without the marks left by water sandpaper.[10] The analysis of surface roughness associated with scanning electron microscopy met the aims after these steps were carried out. At last, final polishing is performed with woolen discs and low abrasive liquids.[10] After that last step, the morphology of the acrylic surface caused surface smoothness to increase.

It is worth noting that the methods of analysis through scanning electron microscopy and laser profilometer give useful information about the morphology and roughness of the samples surfaces in a micrometrical scale. For further investigations carried out in smaller scales, other tools such as atomic force microscopy, must be used.[17]

FINAL CONSIDERATIONS

Before an orthodontic appliance is placed into the mouth, it should be highly polished. The rough surface of the orthodontic appliance makes it uncomfortable, promotes dental plaque accumulation and biofilm formation, thus, reducing resin shining. Furthermore, smooth and polished surfaces are less prone to bacterial colonization, therefore, they are more desirable.

Highly smooth acrylic resin surfaces are obtained after mechanical finishing and polishing performed with burs, wood sandpapers, water sandpapers, pumice, and low abrasive liquids (Kaol).

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Clinical evaluation of dental alignment and leveling with three different types of orthodontic wires

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Introduction: A wide variety of orthodontic wires made of different alloys is available to be used in orthodontic practice and may produce different clinical responses during tooth movement.

Objective: This research evaluated the alignment and leveling of lower dental arches after the use of three types of orthodontic wires.

Methods: A sample of 36 patients was randomly divided into 3 groups: stainless steel, multistranded steel and super-elastic nickel-titanium, according to the first leveling arches used. In order to observe differences in tooth position and axial inclination of the lower incisors, all patients had lateral cephalometric radiographs taken before the insertion of the first arches and 2 months later. The irregularity index and the curve of Spee were measured, compared between groups and considered influential on the proclination of incisors during the initial phase of alignment and leveling. The Reflex microscope was used to measure the irregularity index, whereas the ANOVA analysis of variance was used to verify differences between groups with regard to the degree of dental alignment and leveling.

Results: There were significant differences between groups only at T_2 for the irregularity index.

Conclusion: The NiTi and multistranded steel wires showed greater aligning capacity when compared with stainless steel wires.

Keywords: Orthodontic wires. Physical properties. Tooth movement. Orthodontics.

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INTRODUCTION

Alignment and leveling of teeth generally constitute the most important preliminary clinical phase of any orthodontic treatment with fixed appliances. Leveling is the process in which the incisal edges of the anterior teeth and the buccal cusps of the posterior teeth are placed on the same horizontal level; and alignment is the lining up of teeth of an arch in order to achieve normal contact point relationships.[1,2] The process of leveling can be orthodontically performed by means of different techniques, and, in more severe cases, with the aid of surgical procedures.[2-5] The leveling of the curve of Spee by intrusion of anterior teeth and/or extrusion of posterior teeth is important to achieve functional occlusion.[1,3,6,7,8]

The length of the arch can be increased during leveling of the curve of Spee, mostly by incisor proclination, but how much it is increased has not been very well defined yet.[1] The general concept that additional arch space is necessary to level the occlusal plane could be associated with the continuous archwire mechanics adverse effects produced during leveling. Generally, the response to the use of such arches includes the extrusion of lower premolars, some degree of uprighting of lower molars and proclination of lower incisors.[9] The amount of increase in arch length and incisor proclination during leveling should be carefully planned,[1] and space analysis before leveling should not only be calculated in relation to the sagittal, but also in relation to the vertical and transversal planes.[10]

According to orthodontic theories, light and continuous forces are desirable to obtain physiologic and controlled movement of teeth and adjacent structures. Orthodontic wires used for initial leveling and aligning must be capable of generating such forces and to do so they need to be flexible and to transmit light forces in a wide range of activation. For this reason, a variety of multistranded steel wires or superelastic nickel-titanium wires (NiTi) were developed to provide a force-deflection curve with a definite platform and a wider range of activation.[11]

At first, the elastic behavior of orthodontic wires was evaluated by *in vitro* tests.[12] In an attempt to provide clinical significance to recent laboratory tests, several characteristics have been described as necessary for a fine clinical performance of a wire during leveling and alignment, namely: high resistance to orthodontic forces, low elasticity module, high springback and resilience, easy engagement to the brackets, flexibility, biocompatibility, low friction coefficient, resistance to corrosion and hypoallergenicity, absence of fracture under orthodontic forces.[13,14,15]

Only a few studies have evaluated the new alloys that comprise the archwires used in the initial phase of treatment, and none of them were capable to prove the superiority of nickel-titanium wires over other wires used for aligning and leveling the teeth.[13,16,17,18] The clinical relationship between dental arch expansion, incisor proclination and effectiveness of orthodontic wires is still not clear.

In a recent clinical study,[19] which compared the efficiency of three sequences of NiTi orthodontic archwires produced by different manufacturers (3M Unitek, GAC and Ormco), the differences between alignment efficiency, overall discomfort experience and the time required to reach the working archwire were not significant. Pandis et al[20] clinically evaluated mandibular anterior crowding alleviation performed with CuNiTi and NiTi wires. Their results did not find significant differences between wires with regard to alignment efficiency and treatment duration. Moreover, a recent systematic review was unable to show which is the most effective archwire sequence for leveling and aligning the teeth, due to the lack of *in vivo* studies.

Thus, it becomes necessary to compare the clinical performance of conventional alloys, such as stainless steel and multistranded archwires, with the newer ones, such as superelastic nickel-titanium wires and the heat activated alloys, with regard to incisor proclination and leveling of the curve of Spee. For this reason, the aim of this study was to clinically evaluate the effectiveness of three different types of wires regarding lower incisors proclination, irregularity index and the level of the curve of Spee.

MATERIAL AND METHODS

Thirty-six young adolescents with a mean age of 14 ± 2 years, 18 boys and 18 girls, were selected to begin orthodontic treatment. They were selected according to the following criteria: presence of all erupted permanent teeth except for second and third molars; no previous orthodontic treatment; no indications for tooth extraction; overbite and overjet that allowed brackets to be placed on the lower teeth without occlusal interferences; level of crowding and teeth position that allowed a maximum deflection of 2 mm in the archwire when inserted in the bracket slots,[19,20] and good conditions of oral hygiene and health.

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Diagnosis, suitable treatment planning and prognosis for each case were determined before treatment onset, based on patient's initial records. The project was submitted and approved by the Institutional Review Board. For legal purposes, parents received and signed Institutional Review Board-approved consent forms.

Lower dental casts and lateral cephalometric radiographs were obtained before treatment (T_1), and standard edgewise brackets (0.022-inch slot - Dentsply-GAC International) were directly bonded to all mandibular teeth except molars. The first and second mandibular molars received prefabricated bands on which 0.022-inch slot - Dental Morelli brackets were welded.

The patients were randomly divided into 3 groups according to the type of precontoured archwire used: Group I (n = 11): stainless steel 0.014-inch lower (SS Gold Accuform, Dentsply-GAC International); Group II (n = 12): multistranded stainless steel 0.015-inch lower (SS Pentacat Accuform, Dentsply-GAC International) and Group III (n = 13): superelastic nickel-titanium 0.014-inch lower (Sentalloy, Light Accuform, Dentsply-GAC International).

The wires were inserted as deep as possible into the bracket slots and tied with 0.008-inch metallic ligature by the same operator. Eight weeks later, the archwires were removed and new dental casts and lateral cephalometric radiographs (T_2) were obtained.

On lateral cephalometric radiographs, the structures directly related to the position of the lower incisors were traced (Fig 1) and linear and angular measurements (Fig 2) were obtained for T_1 and T_2 in order to verify changes in the anteroposterior position and axial inclination of the lower incisors.

The irregularity index (II) and the depth of the curve of Spee (CS) were measured in the lower dental casts for T_1 and T_2. The II was calculated by means of the Reflex microscope (Reflex Measurements, Butleigh, UK), by digitizing 22 dental landmarks of the lower dental arch, from the mesial of the first molars to the mesial of the lower central incisors (Fig 3). Three-dimensional coordinates of each landmark were registered and stored by the COMP C3D Server (Motion Lab Systems, Louisiana, USA) and the distances between them were calculated to determinate the irregularity index.[22] In order to measure the depth of the CS, an acrylic plate was placed on the incisal edges of the lower incisors and mesial buccal cusp of the first or second molars, when the latter were present[23] (Fig 4). The distance from the acrylic plate to the buccal cusp of the deepest tooth of each side was measured by a periodontal probe through an opening on the acrylic plate. The mean of the sum of the right and left distances defined the severity of the curve of Spee.[1,21,24]

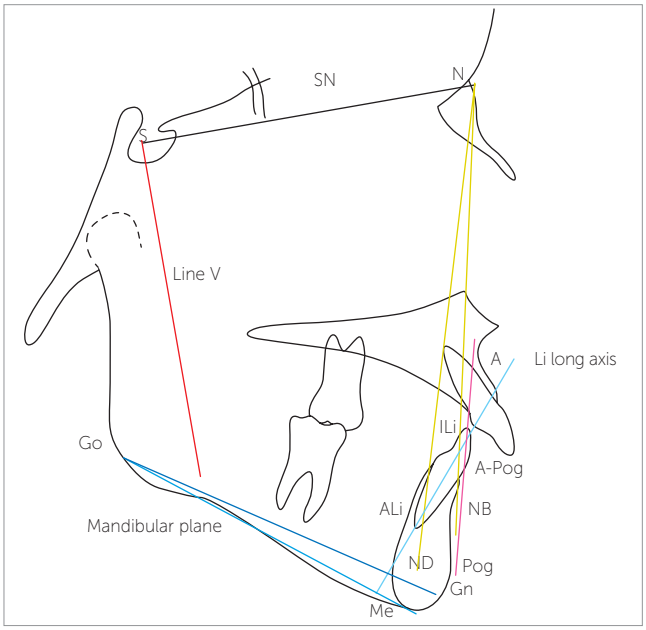


Figure 1 - Tracings, landmarks, lines and cephalometric planes used. The cephalometric landmarks used were as follows: Sela (S), Nasion (N), Point A, Point B, Point D, Gonion (Go), Pogonion (Pog), Gnation (Gn), Menton (Me), ILi (point found on the lower incisor incisal edge) and ALi (point found on top of the lower incisor).

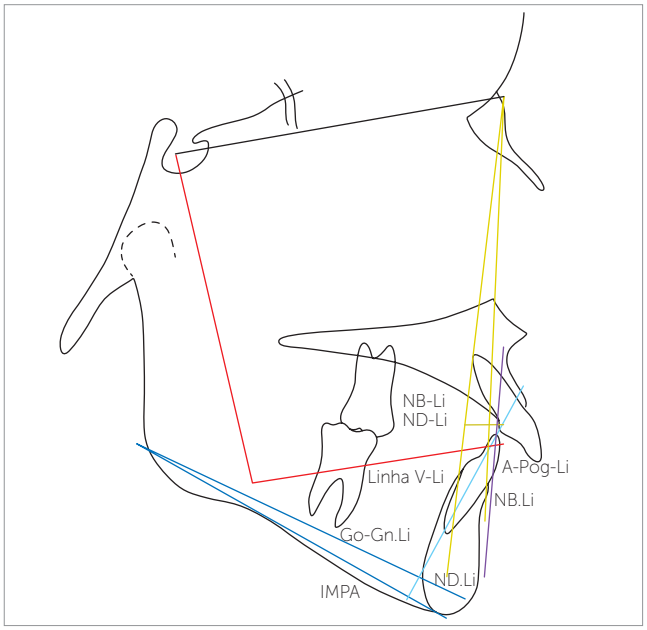


Figure 2 - Cephalometric tracing with the linear and angular measurements used. The linear measurements used were as follows: NB-Li (linear measurement between the NB line and the lower incisor edge, perpendicular to NB), ND-Li, Line V-Li, A-Pog-Li. The angular measurements were as follows: angles NB.Li, ND.Li, IMPA, Go-Gn.Li.

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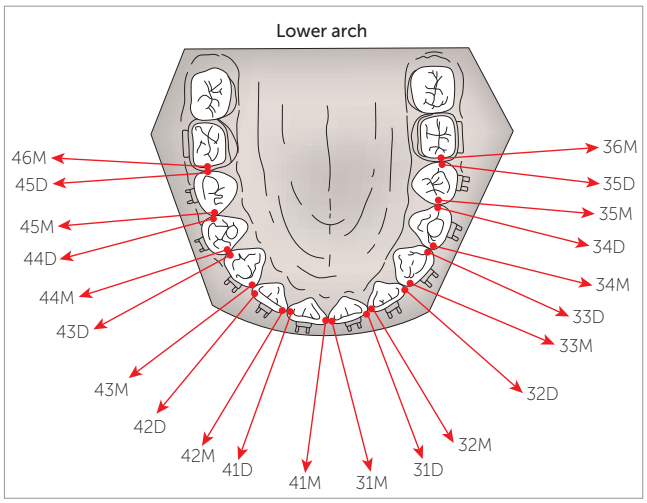


Figure 3 - Diagram of the 22 landmarks digitized on the Reflex microscope.

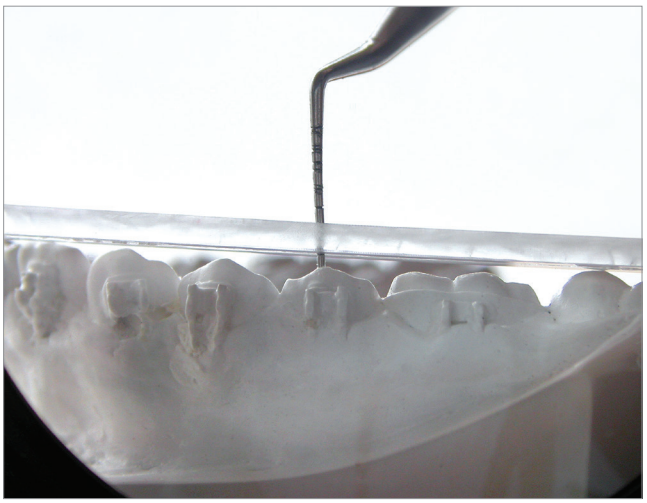


Figure 4 - Method used to measure the depth of the curve of Spee.

Statistical treatment

To determinate the error of the method (reproducibility), four cephalometric radiographs and 36 dental casts (18 for T_1 and 18 for T_2) were randomly selected. The radiographs were traced ten times and the dental casts were measured twice with a minimum interval of a week. No significant differences were found for the cephalometric measurements (ANOVA) and for the irregularity index and the curve of Spee (Student's t-test).

Means and standard deviations were calculated for all variables. The irregularity index, depth of CS and cephalometric measurements values were compared by one-way ANOVA test to evaluate differences between groups at T_1, T_2 and T_2-T_1. The intragroup differences between T_2 and T_1 for the irregularity index, depth of CS and cephalometric measurements were assessed by the Student's t-test. Statistical significance was set at $P \leq 0.05$.

RESULTS

Means and standard deviations are presented for all cephalometric variables, irregularity index and curve of Spee at T_1 (Table 1) and T_2 (Table 2). No statistically significant difference was found between groups, in T_1, which characterizes the homogeneity of the sample.

The differences between T_2 and T_1 for the cephalometric variables showed positive values for all groups, demonstrating a tendency towards labial tipping of lower incisors during initial alignment and leveling, regardless of the type of archwire used. No statistically significant difference was found between groups (Table 3).

Statistically significant differences were found for the irregularity index between T_2 and T_1 in the NiTi ($P = 0.003$) and multistranded groups ($p = 0.016$), only. However, the T_2-T_1 values exhibited no significant differences among three groups (Table 3).

Neither intragroup nor intergroup differences were found for CS between T_2 and T_1 for all three groups, and for T_2-T_1 values, respectively, even though the conventional stainless steel wires demonstrated a higher capacity of occlusal leveling, if compared with the other groups (Table 3).

With respect to the irregularity index at T_2-T_1, conventional stainless steel wires presented the lowest capacity for alignment when compared with the other two groups, however, no significant difference was found between groups.

DISCUSSION

The irregularity index and the depth of the curve of Spee are directly related to the space that is necessary for occlusal leveling, and are considered as influential factors over the amount of incisor proclination during alignment and leveling.[1,9,10,21]

It is well known that a continuous wire, when tied to unaligned and unleveled teeth, assumes the position of the arch and, therefore, requires more wire length than what would be necessary for a leveled and aligned arch. When attempting to return to its original form during alignment and leveling, the wire increases its length in the straight plane, which can explain the tendency towards lower incisor proclination observed in the three types of wires used.[25]

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Table 1 - Mean, standard deviation values and comparison between groups at T_1 for cephalometric measurements, irregularity index and curve of Spee.

	Group I stainless steel	Group II multistranded	Group III Superelastic NiTi	P-value (ANOVA)
NB-Li	7.4 ± 3.8	5.9 ± 1.6	6.4 ± 1.9	0.44
ND-Li	11.5 ± 4.2	10.0 ± 2.3	10.7 ± 2.7	0.47
Line V-Li	60.1 ± 5.6	60.2 ± 7.0	58.6 ± 5.4	0.75
A-Pog-Li	4.4 ± 3.7	3.2 ± 1.5	2.8 ± 2.4	0.33
IMPA	97.1 ± 5.4	94.4 ± 5.7	95.0 ± 6.1	0.51
GoGn-Li	99.7 ± 5.7	97.0 ± 5.8	97.7 ± 6.1	0.54
NB.Li	31.8 ± 6.0	28.9 ± 4.9	29.3 ± 5.2	0.38
ND.Li	28.8 ± 5.7	26.1 ± 4.5	26.3 ± 4.6	0.34
Irregularity Index	232.1 ± 48.5	210.2 ± 37.2	205.7 ± 34.8	0.26
Curve of Spee	4.1±2.6	4.8±1.8	5.0±2.0	0.56

Table 2 - Mean and standard deviation values at T_2 for cephalometric measurements, irregularity index and curve of Spee for the groups.

	Group I	Group II	Group III
NB-Li	8.0 ± 3.4	6.4 ± 2.1	7.4 ± 1.6
ND-Li	12.2 ± 3.9	10.4 ± 2.7	11.6 ± 2.1
Line V-Li	60.7 ± 6.0	60.9 ± 7.4	59.9 ± 5.5
A-Pog-Li	5.0 ± 3.1	3.7 ± 1.6	3.7 ± 1.7
IMPA	99.3 ± 5.7	95.5 ± 6.9	97.4 ± 5.7
GoGn-Li	102.0 ± 5.9	98.2 ± 7.4	100.1 ± 5.6
NB.Li	34.1 ± 5.4	30.0 ± 5.5	31.9 ± 4.1
ND.Li	31.2 ± 4.9	27.4 ± 5.1	28.8 ± 3.8
Irregularity Index	221.2 ± 52.5	180.9 ± 54.1	178.1 ± 33.0
Curve of Spee	3.4±2.2	4.6±1.3	4.9±1.6

Table 3 - Mean values for T_2-T_1 and comparison between T_2 and T_1 for cephalometric measurements, irregularity index and curve of Spee for the groups.

	Group I		Group II		Group III		P-value* (ANOVA) T_2-T_1
	T_2-T_1	P-value* (T_2/T_1)	T_2-T_1	P-value* (T_2/T_1)	T_2-T_1	P-value* (T_2/T_1)	
NB-Li	0.7 ± 0.8	0.27	0.5 ± 0.8	0.19	1.1 ± 1.2	0.36	0.36
ND-Li	0.7 ± 0.5	0.15	0.4 ± 1.0	0.38	1.0 ± 1.2	0.11	0.36
Line V-Li	0.6 ± 1.1	0.23	0.8 ± 1.3	0.13	1.3 ± 1.2	0.23	0.35
A-Pog-Li	0.6 ± 0.9	0.33	0.5 ± 0.9	0.38	0.8 ± 1.2	0.07	0.76
IMPA	2.2 ± 2.0	0.38	1.1 ± 2.8	0.21	2.4 ± 3.2	0.92	0.47
Go-Gn-Li	2.4 ± 1.9	0.41	1.1 ± 3.1	0.61	2.4 ± 3.5	0.55	0.47
NB.Li	2.3 ± 1.9	0.41	1.1 ± 2.6	0.82	2.6 ± 2.9	0.49	0.33
ND.Li	2.4 ± 2.1	0.32	1.3 ± 2.8	0.13	2.5 ± 2.9	0.55	0.46
Irregularity Index	-10.8±36.6	0.35	-29.2±33.4	0.016	-27.6±26.5	0.003	0.33
Curve of Spee	-0.6	0.07	-0.2	0.64	-0.1	0.73	0.50

* Statistical significance was established at $P \leq 0.05$ (Student´s t-test).

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In the lower arch, less potential for tooth movement could be expected with the stainless steel wires when compared with nickel-titanium wires, due to the shorter inter-bracket distance between the lower incisors.[12] Reduction in inter-bracket distance decreases wire flexibility, reducing its resilience and making it difficult to bend and fit into the brackets, which ends up reducing the capacity of tooth movement. On the other hand, the NiTi wires were expected to have an increased potential for tooth movement, since they are more resilient, flexible and easier to fit into the brackets, demonstrating better mechanical properties, specially in the lower incisor region.[26] This could explain the greater aligning capacity of the NiTi wires in comparison to the stainless steel wires, found in this study. The NiTi wire was the only one which significantly improved the irregularity index. When comparing different types of NiTi wires (non-superelastic, superelastic and heat-activated), however, no evidence was found with regard to the efficiency in aligning the mandibular arch. It was concluded that clinical factors, such as the loading pattern of the archwires, may effectively eliminate the advantages of superelastic NiTi observed in the laboratory.[19,20]

Even though no statistically significant differences were found, the NiTi wire presented greater clinical tendency towards incisor proclination, followed by stainless steel wires and by the multistranded steel wires. This finding is in agreement with Wass,[19] who reported that when a 2 mm deformation is placed on a NiTi wire, a maximum load of 365 gf could be reached, and clinically significant incisor proclination would be expected.

The same reasoning could be applied to the multistranded steel wires which demonstrated a significant greater aligning capacity in comparison to the stainless steel wires, despite demonstrating a non-significant, inferior incisor proclination tendency. Such finding could be explained by the low springback and deformation resistance of the multistranded steel wires, which reduce their energy storage capacity when tied.

In the two most recent clinical studies[19,20] comparing the aligning efficiency of different NiTi and CuNiTi orthodontic archwires, the incisor proclination tendency and the leveling of the curve of Spee were not measured. Moreover, Little's[27] irregularity index, which is bidimensional, was used in both studies to quantify the degree of tooth alignment of the six anterior mandibular teeth. In the present study, the II was calculated by means of the Reflex microscope,[12,16] with three-dimensional coordinates for each landmark digitized in the study models. It gave more accuracy to this measure, since the space discrepancy could be calculated not only in relation to the sagittal, but also in relation to the vertical and transversal planes. Incisor proclination and leveling of the curve of Spee were also calculated because they represent important factors for the stability of the treatment.

In clinical studies, however, it is important to describe the tendencies observed even when significant differences are not found[12], since the statistical mean does not always reflect the clinical result.[11] In such case, based on the linear and angular means, it is suggested that the NiTi wires presented a greater clinical tendency towards incisor proclination, even though statistically significant differences were not found. These findings agree with Jones et al[16] who did not observe clinically significant differences between dental alignment in 43 patients that used NiTi superelastic 0.014-inch or multistranded steel 0.015-inch arches, even though the NiTi wire demonstrated greater clinical action in the lower incisor region. Pandis et al[20] in agreement with the present study and with the findings of Jones et al[16] did not find differences in the amount of aligning in 60 patients who randomly received 0.016-inch CuNiTi 35°C (Ormco, Glendora, Calif) or 0.016-inch NiTi (Modern-Arch, Wyomissing, Pa) wires. In the most recent clinical study, it was determined that a minimum number of 120 patients was required to detect a clinically significant difference between the aligning arches with a power of 0.99 to a significance level of $P < 0.0519$. This could explain the absence of statistically significant differences in the three studies above.

A tendency for lower incisor proclination has been observed for the three types of wires. This fact is in agreement with Braun et al[24] who describe that even if the wires are fastened by tie backs or have their ends cinched back after the molar tubes, incisor labial inclination would occur simultaneously to its intrusion during leveling of an accentuated curve of Spee when a continuous archwire or a reverse curve of Spee is used. Such movement would occur because of the system of forces that is created and great part would be minimized if the teeth were leveled with segmented arch mechanics.[24]

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The influence of the type of orthodontic wire alloy over lower incisor proclination could be questioned. This study did not use any type of mechanics that could prevent proclination, so that the potential of each alloy, regarding lower incisor proclination could be assessed without the influence of other factors.

For malocclusions similar to the studied ones, the type of wire used did not determine relevant differences regarding initial incisor proclination and initial leveling of the curve of Spee. With regard to malocclusion, patients who used the different alloy wires would not present significant differences in relation to the initial incisor proclination and the level of the curve of Spee. However, when comparing the irregularity index at T_2, the NiTi and multistranded steel wires showed greater aligning capacity in comparison to stainless steel wires. Therefore, it could be inferred from this study that a correct mechanical treatment planning for each case is much more important than the action of a certain wire.

CONCLUSION

No statistically significant differences were found between the changes in cephalometric positions and lower incisor axial inclinations with the three orthodontic wires used. No intergroup differences regarding the leveling of the curve of Spee with the insertion of only one archwire for an 8-week period were found. Statistically significant differences were found between groups with regard to the irregularity index values in T_2, as the NiTi and multistranded steel wires showed greater aligning capacity when compared with stainless steel wires.

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Cone beam tomographic study of facial structures characteristics at rest and wide smile, and their correlation with the facial types

Luciana Flaquer Martins[1], Julio Wilson Vigorito[2]

Objective: To determine the characteristics of facial soft tissues at rest and wide smile, and their possible relation to the facial type.

Methods: We analyzed a sample of forty-eight young female adults, aged between 10, 19 and 40 years old, with a mean age of 30.9 years, who had balanced profile and passive lip seal. Cone beam computed tomographies were performed at rest and wide smile postures on the entire sample which was divided into three groups according to individual facial types. Soft tissue features analysis of the lips, nose, zygoma and chin were done in sagittal, axial and frontal axis tomographic views.

Results: No differences were observed in any of the facial type variables for the static analysis of facial structures at both rest and wide smile postures. Dynamic analysis showed that brachifacial types are more sensitive to movement, presenting greater sagittal lip contraction. However, the lip movement produced by this type of face results in a narrow smile, with smaller tooth exposure area when compared with other facial types.

Conclusion: Findings pointed out that the position of the upper lip should be ahead of the lower lip, and the latter, ahead of the pogonion. It was also found that the facial type does not impact the positioning of these structures. Additionally, the use of cone beam computed tomography may be a valuable method to study craniofacial features.

Keywords: Diagnosis. Cone beam computed tomography. Smile.

» The patient displayed in this article previously approved the use of her facial and intraoral photographs.

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INTRODUCTION

One of the first facial esthetic concepts in Orthodontics was conceived by Angle,[1] who related perfect tooth intercuspation to the existing harmony between dental skeletal and facial structures. Case[2] has stated that even in face of lack of tooth contact and adequate masticatory function cases, patients could occasionally present reasonable facial esthetics. He also observed that all "beautiful" faces exhibited the following features: passive labial seal, good relation between the zygoma and the upper lips, lower lips slightly retracted in relation to the upper lips, and protruded chin.

Diagnosis and orthodontic planning were developed based on cephalometric studies, using lines, planes and angles aiming at quantifying the features of the craniofacial complex in addition to determining normality parameters and goals to be achieved at the end of the orthodontic treatment.[3-6]

From the 70's onwards, esthetic parameters assessments have been described as essential to treatment planning, associating Orthodontics to Orthognatic Surgery. Nevertheless, using cephalometric radiographs only is considered insufficient, since soft tissue characteristics would be better visualized by pictures.[7-12]

The incorporation of cone beam computed tomography (CBCT) techniques to Dentistry allowed comparison between soft and hard tissue structures, without overlaps or magnifications, providing data that correspond to the patient's real measurements.[14,15]

The possibility of a better appreciation of craniofacial structures improved not only the accuracy in landmarks demarcation, but also the precision of conventional cephalometric analysis[16,17,18,19,20,21] and it is likely that new assessment techniques might come up and change the current craniofacial analysis paradigms.[16,17,19]

Our purpose in this paper was to assess the soft tissue features of the face, nose, lips, zygoma and chin, both at rest and during wide smile positions, and their possible relation to the facial type. In order to accomplish that, we used cone beam computed tomographies, once they provide us with a better visualization and a more comprehensive approach for orthodontic diagnosis when compared with traditional methods.[18-21]

MATERIAL AND METHODS

The project for this article was approved by the University of Sao Paulo College of Dentistry Institutional Review Board, under report number 17/2008. This research assessed 48 female subjects aged between 19.10 and 40 years old, with a mean age of 30.9 years old, caucasian, who had passive lip seal . None of the patients had previously taken part on research activities, facial surgeries (plastic or orthognatic) and had never undergone any facial esthetic intervention.

Facial Index was used to determine each patient's facial type. Patients' faces were photographed with facial soft tissues at rest and with guided NHP,[22] according to Vigorito e Martins.[26]

Each patient's image was inserted into the Radiocef Studio 2 computer software (Radio Memory Ltda, Belo Horizonte — Brazil), by means of which the facial type was obtained according to the anthropometric Facial Index.

Calculations were done using the following formula:

N'-Me'x 100 / ZiR'-ZiL'

Once Facial Index had been determined, patients were classified as brachifacial, mesofacial or dolicofacial according to the following parameters:[23,26]

- Brachifacial: between 80.0 and 84.9%.
- Mesofacial: between 85.0 and 89.9%.
- Dolicofacial: between 90.0 and 95.0% or higher.

Following the aforementioned proportions, sample was subdivided into three groups with sixteen subjects each (Brachifacial, Mesofacial and Dolicofacial).

After the facial type had been determined, cone beam computed tomographies were taken by an i-Cat (Imaging Sciences International Hatfield, PA — USA) digital tomography scanner, at two stages: 1- With facial soft tissues at rest; 2- Wide smile.

All measurements were obtained through the i-CAT Vision (Imaging Sciences International Hatfield, PA — USA) computer software at the MPR visualization screen, (multi-plane reconstruction).

For the purpose of this study, true horizontal determination was chosen by means of a single intracranial landmark (Sela), tracing a perpendicular line departing from it, this being the true vertical.[24] This technique, together with guided natural head position, is suggested to avoid that possible variations between intracranial planes and lines diverge from the true horizontal line.[23,24]

For frontal assessment visualization, the 3DVR 5.0 (Imaging Sciences International Hatfield, PA — USA) 3D computer software was used.

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Variables used in tomographic soft tissue cephalometric assessment

Axial section (Fig. 1):

1) Zygomatic thickness (Zygoma point; zygomatic soft tissue point, left and right sides); 2) Nose width (left and right alar); 3) Base of the nose width (left to right nasal base)

Sagittal section (Fig. 2):

1) Snv-Ul (upper lip position in relation to the vertical subnasal line); 2) Snv-Ll (lower lip position in relation to the vertical subnasal line); 3) Snv-Pog' (pogonion position in relation to the vertical subnasal line); 4) H-nose (distance from the tip of the nose to line H); 5) Nose height (distance from pro-nasal to the true horizontal line); 6) Collumela height (distance from collumela to true horizontal); 7) Upper lip height (distance from the stomion to subnasal point); 8) Lower lip height (distance from stomion to mental lip point); 9) Upper lip thickness (distance between vertical prosthion to the tip of the upper lip); 10) Lower lip thickness (distance from vertical infradentale to the tip of lower lip); 11) Distance between labial apexes (distance between upper and lower lip width lines); 12) E-Ll (distance from line E and the lower lip).

Frontal view (Figs 4 and 5):

1) Upper lip vermilion height (distance between the most central upper lip point to the stomion, marked over the midline); 2) Lower lip vermilion height (distance between the stomion and the inferior portion of the lower lip, marked over the midline); 3) Distance between right and left labial comissures; 4) Labial height (distance between the upmost part of the upper lip and the lowest part of the lower lip, marked over the midline); 5) Labial index (proportional distance between comissures and labial height, at rest); 6) Smile index (proportional distance between the comissures and labial height, at wide smile); 7) Teeth exposure area.

STATISTICAL METHOD

Facial structures movements were calculated for each patient by subtracting the value at rest from the

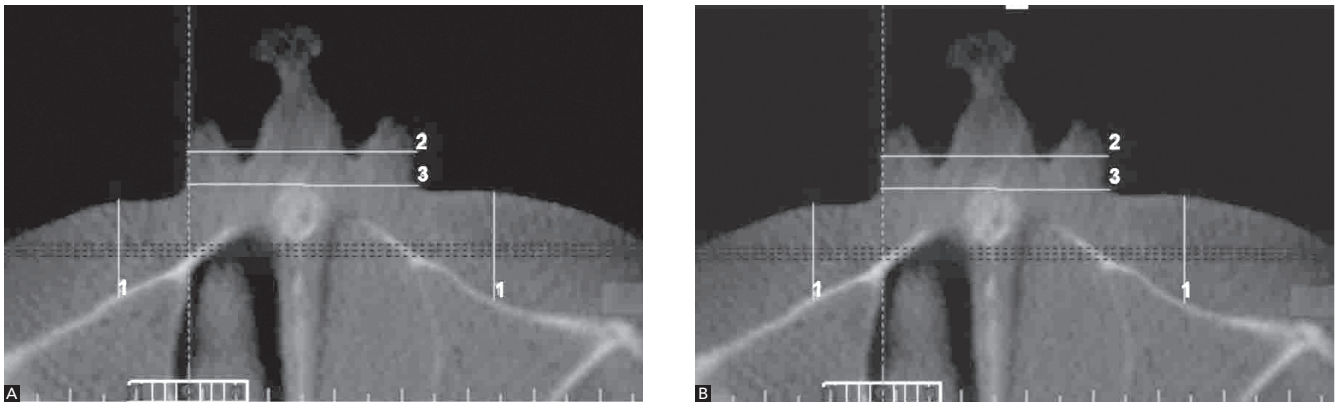


Figure 1 - Variables studied in axial section at rest (A) and wide smile (B).

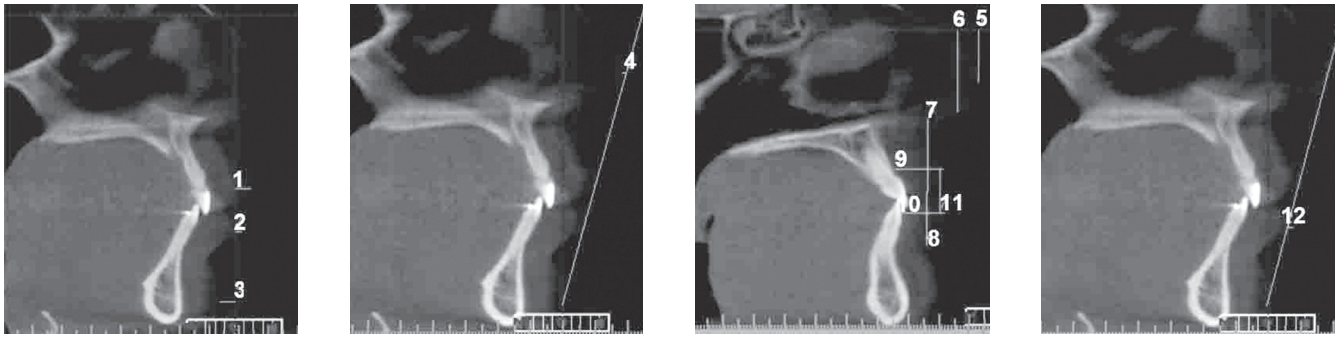


Figure 2 - Variables studied in sagittal section at rest.

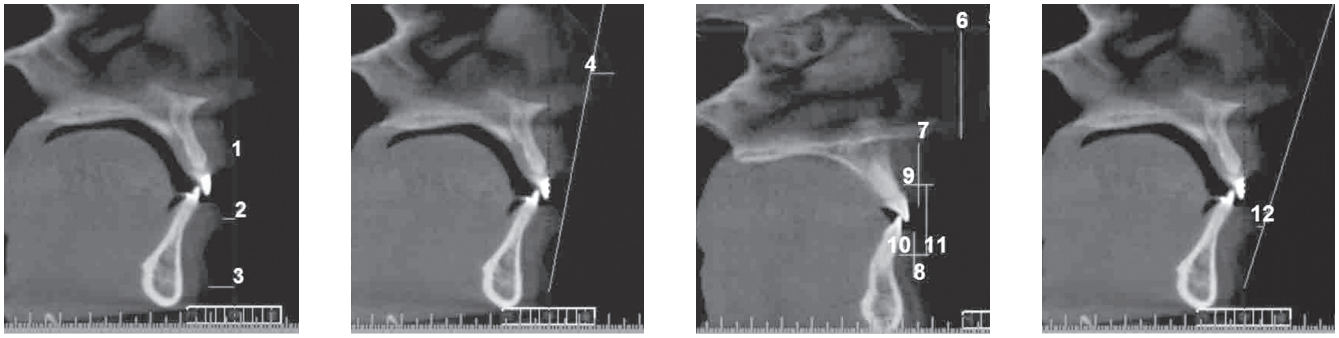


Figure 3 - Variables studied in sagittal section during wide smile.

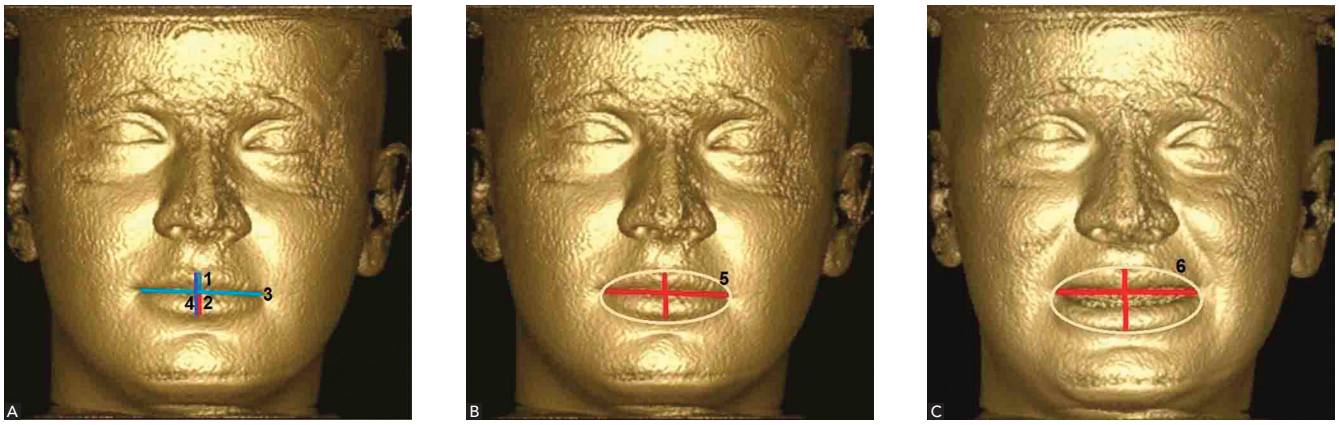


Figure 4 - Variables studied in tridimensional view of the face at rest (**A** and **B**) and during wide smile (**C**).

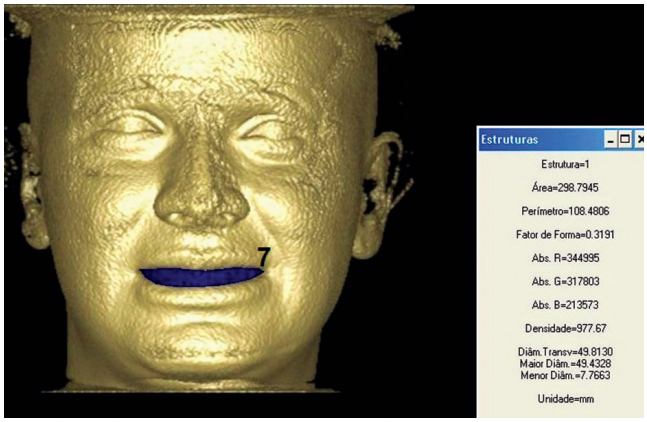


Figure 5 - Tooth exposure area, calculated by tridimensional view of the face during wide smile.

wide smile value. Each facial movement measurement was compared between facial types by means of analysis of variance (one-way ANOVA),[25] followed by Bonferroni[25] multiple comparisons when the ANOVA presented statistically significant differences while checking which facial types presented distinct facial movement.

In order to assess the relationship between smile index and teeth exposure area, Pearson's correlations were calculated separately for each face type, for the whole sample.

RESULTS

Results are shown in Tables 1 to 8.

Table 1 - ANOVA analysis of variance of the difference between facial types at rest and wide smile, in axial tomographic section.

Variable	Facial type						P
	Brachifacial		Mesofacial		Dolicofacial		
	Mean ± SD	n	Mean ± SD	n	Mean ± SD	n	
Left zygomatic thickness	5.11 ± 2.48	16	3.93 ± 2.28	16	3.11 ± 1.64	16	0.04
Right zygomatic thickness	5.25 ± 2.34	16	3.83 ± 2.22	16	3.17 ± 1.84	16	0.027
Nose width	4.42 ± 3.54	16	3.74 ± 2.83	16	3.12 ± 2.59	16	0.479
Nasal base width	5.24 ± 2.68	16	4.3 ± 1.93	16	4.13 ± 2.12	16	0.336

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Table 2 - Bonferroni analysis of measurements presenting statistically significant differences between rest and wide smile, in axial tomographic section.

Variable	Comparison		Mean difference	Standard Error	P	CI (95%)	
						Lower	Upper
Left zygomatic thickness	Brachifacial	Mesofacial	1.18	0.76	0.388	-0.72	3.08
	Brachifacial	Dolicofacial	2	0.76	0.036	0.1	3.9
	Mesofacial	Dolicofacial	0.82	0.76	0.87	-1.08	2.72
Right zygomatic thickness	Brachifacial	Mesofacial	1.42	0.76	0.203	-0.47	3.3
	Brachifacial	Dolicofacial	2.08	0.76	0.026	0.2	3.97
	Mesofacial	Dolicofacial	0.66	0.76	1	-1.22	2.55

Table 3 - ANOVA analysis of variance of the difference between facial types at rest and wide smile, in sagittal tomographic section.

Variable	Facial type						
	Brachifacial		Mesofacial		Dolicofacial		P
	Mean ± SD	n	Mean ± SD	n	Mean ± SD	n	
Nose Height	-0.24 ± 3.57	16	-0.1 ± 3.53	16	0.67 ± 4.25	16	0.767
Collumela Height	-0.23 ± 3.13	16	-0.01 ± 4.17	16	0.18 ± 4.54	16	0.959
Upper Lip Height	-4.78 ± 2.23	16	-4.51 ± 1.97	16	-4.84 ± 1.71	16	0.879
Lower Lip Height	-0.85 ± 1.64	16	-1.26 ± 1.99	16	-1.97 ± 1.98	16	0.245
Upper Lip Thickness	-4.66 ± 1.37	16	-3.39 ± 1.58	16	-3.56 ± 1.21	16	0.027
Lower Lip Thickness	-5.2 ± 1.74	16	-5.11 ± 1.58	16	-4.62 ± 1.66	16	0.57
Distance between Labial Apexes	6.59 ± 2.4	16	8.33 ± 2.81	16	7.51 ± 1.96	16	0.137
Upper Lip Position	-3.2 ± 1.42	16	-1.32 ± 1.76	16	-2.23 ± 1.54	16	0.007
Lower Lip Position	-3.86 ± 2.23	16	-3.13 ± 2.03	16	-4.11 ± 2.24	16	0.417
Pogonion	-0.74 ± 2.99	16	1.29 ± 3.28	16	-1.01 ± 3.02	16	0.083
Line E-Li	-2.89 ± 4.46	16	-4.28 ± 2.13	16	-2.94 ± 1.83	16	0.35
H-Nose	5.96 ± 1.93	16	5.87 ± 2.8	16	4.13 ± 5.86	16	0.335

Table 4 - Bonferroni analysis of measurements presenting statistically significant differences between rest and wide smile, in sagittal section.

Variable	Comparison		Mean difference	Standard Error	p	CI (95%)	
						Lower	Upper
Upper Lip Thickness	Brachifacial	Mesofacial	-1.27	0.49	0.04	-2.49	-0.04
	Brachifacial	Dolicofacial	-1.11	0.49	0.089	-2.33	0.12
	Mesofacial	Dolicofacial	0.16	0.49	1	-1.06	1.39
Upper Lip Position	Brachifacial	Mesofacial	-1.87	0.56	0.005	-3.26	-0.48
	Brachifacial	Dolicofacial	-0.96	0.56	0.274	-2.35	0.43
	Mesofacial	Dolicofacial	0.91	0.56	0.335	-0.48	2.3

Table 5 - ANOVA analysis of variance of the difference between facial types at rest and wide smile, in frontal view.

Variable	Facial type						
	Brachifacial		Mesofacial		Dolicofacial		p
	Mean ± SD	n	Mean ± SD	n	Mean ± SD	n	
Distance between comissures	12.37 ± 5.75	16	9.6 ± 4.04	16	9.6 ± 4.85	16	0.197
Labial Height	5.75 ± 3.32	16	7.09 ± 3.3	16	7.77 ± 2.88	16	0.198
Upper lip Vermilion Height	-1.29 ± 1.21	16	-1.25 ± 0.99	16	0.09 ± 0.93	16	0.001
Lower lip Vermilion Height	-0.81 ± 1.04	16	-0.93 ± 0.75	16	-0.37 ± 0.43	16	0.113
Labial/Smile Index	-0.02 ± 0.42	16	-0.25 ± 0.25	16	-0.27 ± 0.26	16	0.059

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Table 6 - Bonferroni analysis of upper lip vermilion height presenting statistically significant differences between facial types at rest and wide smile, in frontal view.

Variable	Comparison		Mean difference	Standard Error	p	CI (95%)	
						Lower	Upper
Upper lip vermilion Height	Brachifacial	Mesofacial	-0.04	0.37	1	-0.96	0.89
	Brachifacial	Dolicofacial	-1.38	0.37	0.002	-2.3	-0.45
	Mesofacial	Dolicofacial	-1.34	0.37	0.002	-2.26	-0.42

Table 7 - ANOVA analysis of variance of teeth exposure area between different facial types, in frontal view.

Variable	Facial type						
	Brachifacial		Mesofacial		Dolicofacial		p
	Mean ± SD	n	Mean ± SD	n	Mean ± SD	n	
Teeth exposure area	288.7 ± 158.4	16	435.04 ± 101.38	16	431.9 ± 102.14	16	0.002

Table 8 - Bonferroni analysis of teeth exposure area that presented statistically significant difference between facial types at rest and wide smile, in frontal view.

Variable	Comparison		Average Difference	Standard Error	p	IC (95%)	
						Lower	Upper
Teeth exposure area	Brachifacial	Mesofacial	-146.37	43.69	0.005	-255.01	-37.73
	Brachifacial	Dolicofacial	-143.21	43.69	0.006	-251.85	-34.57
	Mesofacial	Dolicofacial	3.16	43.69	1	-105.48	111.8

DISCUSSION

Considering the fact that the methodology applied to assess facial soft tissues is considerably different from the methodologies described in the literature, the discussion of this paper is restricted to a description of the findings, supplying data so that further researches may be developed and compared to the present one.

For the study of axial section tomographic images, for both rest and wide smile positions, measurements presented no statistically significant difference between the three facial types.

In the dynamic assessment of these structures, determined by the axial section, it was verified that neither the nose width nor the nose base width suffered any changes in different facial types. On the other hand, soft tissues thickness around the zygomatic structures was influenced by wide smile position when comparing different facial types, suggesting that brachifacial subjects present greater muscle movement, translated by increased thickness around the zygoma if compared with dolicofacial subjects (Tables 1 and 2).

When comparing all variables assessed by the sagittal section, both at rest and wide smile, no statistically significant differences were found between facial types.

However, it was found that at both rest and wide smile, upper lip, lower lip and pogonion positions remained invariable: the lower lip with discrete retrusion if compared with the upper lip, and the pogonion slightly retruded if compared with the lower lip, as reported by the literature.[2,4,5,8,24]

Except for the tip of the nose, the nasal collumela and the pogonion, dynamic assessment revealed that height and width of both upper and lower lips as well as the esthetic positioning of these structures, presented significant difference between the two phases (Table 3). Except for upper lip thickness and positioning, which tend to thin out as the smile expands in brachifacial subjects, other measurements did not particularize any facial type.

In frontal view, at rest and wide smile, lips and their features were analyzed and no statistical difference was found between measurements and the facial types.

Dynamic assessment of different variables in frontal view revealed a peculiar behavior with regard to the facial types, as follows:

» Brachifacial, the distance between lip comissures and lip height presented significant alteration. Lower lip vermilion height decreased due to vertical muscle contraction (Table 4).

» Mesofacial, all variables studied revealed significant alteration (Table 4).

» Dolicofacial, wide smile measurements were higher than at rest, but the difference between smile and labial indexes pointed out that rest measurements exceeded the wide smile ones. (Table 4).

The dynamic behavior between labial and smile indexes presented a statistical significant difference for mesofacial and dolicofacial types, with labial index exceeding the smile index. These results demonstrate that although muscle movements take place during wide smile , they do not equally involve vertical and horizontal lip distancing, with a larger distance for horizontal distancing if compared with the vertical one.

Bonferroni analysis of upper lip vermilion height (Table 5) revealed that the upper lip vermilion height was greater for brachifacial patients than for dolicofacial ones, and when comparing dolicofacial with mesofacial subjects, this parameter was higher for mesofacial individuals

On comparing the tooth exposure area variable between facial types, as an attempt to distinguish their features, it was observed that there was a statistical significant difference (Table 6) that, when submitted to Bonferroni analysis (Table 7), demonstrated that brachifacial subjects presented lower values if compared with mesio and dolicofacial ones, with no significant difference between the two latter patterns.

Observation of tooth exposure behavior in comparison with the smile index showed no relation between those two variables (Table 8). That confirms the fact that the range of lip movement does not impact total tooth exposure.

CONCLUSION

The results obtained from this research led to the conclusion that in balanced faces, the facial type does not distinguish lip, nose, pogonion or zygoma positioning in soft tissues, neither at rest nor at wide smile position.

That reinforces the importance of orthodontic planning that in addition to being based on bone structures relation, facial growth and dental intercuspation, should also be able to assess soft tissue accommodation towards dental and skeletal tissues as well as facial esthetics, always seeking for the balance between these structures as a final goal of the treatment.

The use of cone beam computed tomography may be a great adjuvant in diagnostic studies that attribute equal weight to both hard and soft tissues analysis, since it allows the assessment of lateral, sagittal and coronal views as well as frontal and profile appreciations of the facial soft tissues.

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The influence of protective varnish on the integrity of orthodontic cements

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Objective: The aim of the present study was to assess the influence of saliva contamination over the structural strength and integrity of conventional glass-ionomer cements used for cementing orthodontic bands in the absence and presence of a surface-protecting varnish.

Method: 48 samples were prepared by inserting 3 types of glass-ionomer cements into standardized metallic matrixes of 10 mm of diameter and 2 mm of depth. The cements used were: Meron (VOCO), Ketac-Cem (3M ESPE) and Vidrion C (DFL), all of which comprised groups A, B and C, respectively. Subgroups A1, B1 and C1 comprised samples with no surface protection, whereas subgroups A2, B2 and C2 comprised samples of which surface was coated with Cavitine varnish (SS White), after cement manipulation and application, in order to protect the cement applied. All samples were stored in artificial saliva for 24 hours at 37°C. A Vickers diamond micro-durometer was used to produce indentations on the non-treated group (non-varnished) and the treated group (varnished).

Results: Varnished materials had significantly higher microhardness values in comparison to non-varnished materials. Ketac-Cem had the highest microhardness value among the varnished materials.

Conclusion: Varnish application is necessary to preserve the cement and avoid enamel decalcification. Glass-ionomer cements should be protected in order to fully keep their properties, thus, contributing to dental health during orthodontic treatment.

Keywords: Glass-ionomer cements. Artificial saliva. Microhardness.

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INTRODUCTION

Maintaining an adequate oral health is a constant challenge in Orthodontics, since the high number of retentive surfaces present in the orthodontic appliances hinders bacterial plaque removal. Some issues involving attachment material, such as poor sealing, inadequate structural and adhesive strength as well as cement solubility in oral fluids contribute to enamel decalcification.[1,2,3]

Failure in band cementation usually results in serious problems for orthodontic treatment. If any failure in cement seal occurring between the band and the tooth is not immediately detected, enamel demineralization may occur at the margins of the band.[4] In addition to attaching the bands, the cement protects the banded tooth against cavity. The resistance of these dental cements to oral fluids can be measured by their solubility and disintegration.[5]

Glass-ionomer cement is a generic denomination for a group of materials produced by the reaction between silicate glass powder and polyacrylic acid.[6] The main characteristics of this material are fluoride release, important for enamel remineralization of carious teeth, biocompatibility, and adhesion to the enamel, which occurs by chemical attraction between the apatite and the polyacrylic acid.[7]

Due to its capacity of adhering to the dental structure and its ability to release fluoride ions, the glass-ionomer cement is indicated not only for preventive restorations, but also as a filling and attaching material.[6] In addition, glass-ionomer cement can adhere to stainless steel, which favors its use as an attaching material.[8]

Bands attached with glass-ionomer cement require less recementations, present less decalcification in the surrounding enamel, and show higher amount of remnant cement after debonding.[9] On the other hand, the glass-ionomer cement has the disadvantage of being susceptible to humidity.[10]

During the initial curing phase of the glass-ionomer cement, any contamination can adversely affect its surface hardness, thus, altering its properties.[11,12] In clinical cases in which contamination control is difficult, its use is contra-indicated.[13] For this reason, it seems to be reasonable to isolate the glass-ionomer cement from the oral environment with impermeable materials during initial curing in order to avoid any undesired changes.

There are several studies in the literature relating materials and their adhesive capacity, particularly using composites and hybrid ionomers on shear bond tests,[14] in addition to those that emphasize bond strength and ts failures.[9,15,16] Other studies have correlated the fluoride-releasing ability of certain materials with their cariostatic effects.[3,9] However, no studies have been carried out on the need for isolating conventional glass-ionomer cements surfaces during cementation of orthodontic bands, even though this action is essential for the preservation and longevity of this type of cement in restorative Dentistry practice.[17]

In this study, Cavitine varnish was chosen for such protection. According to the manufacturer, it is a nitrocellulose-based (8%) varnish with some unique features, including excipients (ethyl acetate, ethanol) which cause it to be volatile and fast-drying. It is used as cavity liner and for protection of silicate restorations, since it prevents salivary action and avoids moisture during crucial reaction steps.

Microhardness is among the properties which may be affected by contamination during the initial curing phase. Surface microhardness is defined as being the microstructure and texture activities of a given material, which are used for predicting material strength as well as its ability of abrading opposite structures.[18] It is, in fact, one of the most important mechanical properties for comparative studies of dental materials.[11] Strength, curing time and erosion of the glass-ionomer cement have evolved as new hardness tests are performed.[19] Knowing the material surface microhardness behavior is crucial when choosing the best material, since this property changes when it is exposed to humidity — condition that is similar to that of the oral cavity.[18]

Therefore, the objective of the present study was to assess the effects of varnish isolation on microhardness of conventional glass-ionomer cements in the presence of salivary contamination during initial curing phase.

MATERIAL AND METHODS

In the present study, conventional glass-ionomer cements were assessed. They were manipulated according to the manufacturer's instructions and only one investigator tested the materials.

Three conventional glass-ionomer cements commonly available on the market were used, namely: Group A (Meron, VOCO, Cuxhaven, Germany, batch 109012051); Group B (Ketac-Cem, 3M ESPE, Seefeld, Germany, batch 221924); and Group C (Vidrion C, DFL, Rio de Janeiro, Brazil, batch 0060406 — powder,

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batch 0010106 — liquid). Each group was divided into two subgroups containing 8 samples each (Subgroups A1, A2, B1, B2, C1, and C2), in which number 1 refers to those samples without isolation after manipulation and application of the cement, and number 2 refers to those samples receiving protection against humidity. A total of 48 samples was obtained and humidity protection was achieved by means of applying Cavitine varnish (SS White, Rio de Janeiro, Brazil, batch 013) onto the cement surfaces.

The samples were obtained by inserting the materials into standardized metallic matrixes of 10 mm in diameter and 2 mm in depth. Insertion was performed by using Centrix syringe (DFL) in order to avoid air bubbles. A glass plate was put onto the matrixes so that a plane surface could be obtained, thus, preserving the surface layer as well as enabling the focus during microhardness test.

After the initial 10 minutes, all samples were immersed into artificial saliva, including those from subgroups A2, B2, and C2 which had been coated with Cavitine varnish by using microbrushes (Cavibrush – FGM). The material was kept in a stove at 37°C for 24 hours.[17]

All samples were kept under moist conditions in order to avoid dehydration and test the varnish efficiency. Artificial saliva was chosen because it increases surface hardness of glass-ionomer cements and simulates the conditions found within the oral environment, which would not happen if distilled water was used.[19]

The microhardness tests were performed by using a Vickers diamond microdurometer (E. LEITZ, Germany) with a 100 gf load being applied during 30 seconds in order to produce indentations, which were measured in Vickers hardness (HV). Five indentations were performed in each sample of each group, with a total of 80 indentations — 40 in varnish-coated samples and 40 in non-varnished ones. The microhardness values were obtained by measuring the diagonal of the imprints magnified by 50 times with ZoomMagic 2.0 software (PeakStar, USA). The results were calculated with the following formula: $HV = 1854.4\ P/d^2$, where P = indentation load and d = diagonal obtained.[11]

Analysis of variance was employed to compare all the subgroups, whereas Tukey's test was used for multiple comparisons. The significance level was set at 1%.

RESULTS

Table 1 and Figure 1 show the microhardness values obtained for all subgroups. They demonstrate that varnish-coated samples had higher microhardness values in comparison to the non-varnished ones ($P < 0.01$). Ketac-Cem glass-ionomer cement (3M ESPE), either varnished or non-varnished, had the highest microhardness value after being stored in artificial saliva for 24 hours.

The varnish-coated samples were found to have smoother and more regular surfaces (Fig 2), as well as the highest microhardness values. On the other hand, cracks and rugosities were observed in the non-varnished samples which also presented inappropriate microhardness values (Fig 3).

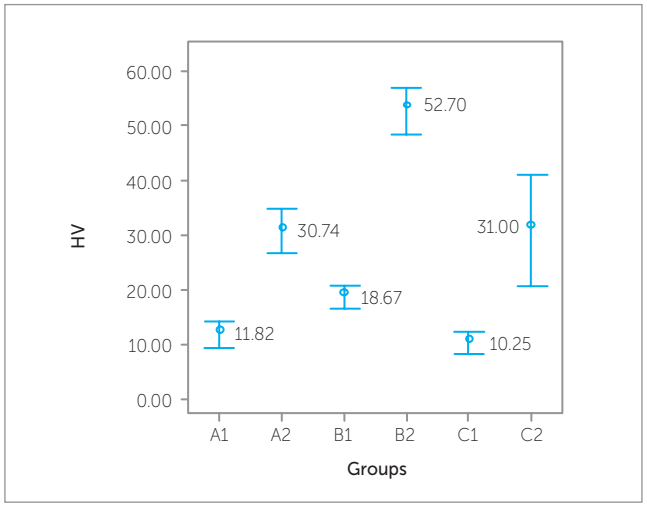


Figure 1 - Graphic representation of microhardness differences found for each subgroup.

Table 1 - Vickers microhardness values (kg/mm²) for different subgroups (mean ± standard deviation).

Group A (Meron, Voco)		Group B (Ketac-Cem, 3M ESPE)		Group C (Vidrion, DFL)	
A1[c]	A2[b]	B1[c]	B2[a]	C1[c]	C2[b]
HV = 11.82 ± 2.73	HV = 30.74 ± 4.88	HV = 18.67 ± 1.74	HV = 52.69 ± 4.27	HV = 10.24 ± 2.39	HV = 31.00 ± 12.21

Superscribed letters indicate statistically significant differences ($P < 0.01$) for a>b>c.

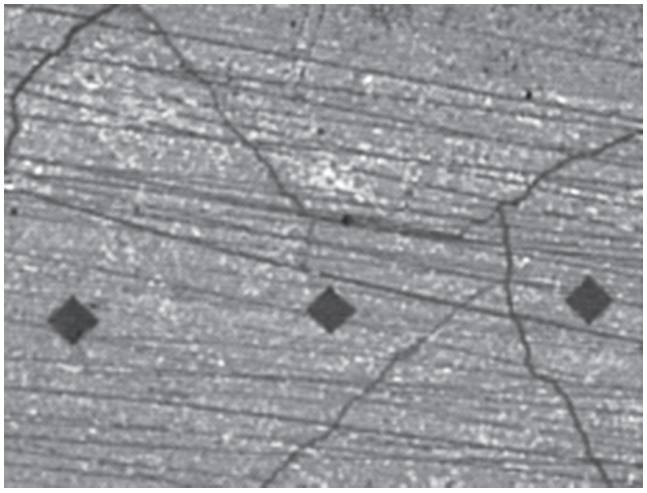


Figure 2 - Subgroup B1 sample surface (non-varnished). Presence of cracks, fissures, and large indentations . 50 times magnification.

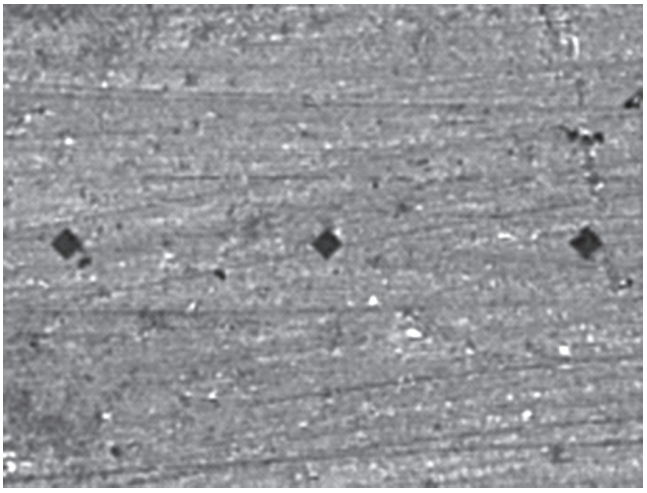


Figure 3 - Subgroup B2 sample surface (varnished). Smooth surface with small indentations. 50 times magnification.

DISCUSSION

Mechanical properties of materials are intimately related to their overall quality and integrity. Material's surface degradation is associated with an increase in rugosity and allows bacteria lodging and, as a consequence, causes undesirable tissue reactions. This explains the need for materials to preserve their mechanical properties, specially hardness.[20,21] Materials with better microhardness are more likely to withstand saliva biochemistry, constant pH variations, different temperatures and, specially, the resident oral microbiome.[22] This is the reason why the present study aimed at verifying surface behavior of 3 types of conventional glass-ionomer cements with regard to humidity and varnish-protection effects. Therefore, the methodology chosen has proved to be adequate.[17]

In the present study, a 10-minute curing time was adopted before saliva contamination, as stated in previous studies.[11,18] The curing time for conventional glass-ionomer cements ranges between 4.4 and 12.2 minutes.[23] The first 10 minutes of chemical reaction are the most important, since acid attack occurs during this period of time, thus, resulting in ion release (fluoride, sodium, calcium, aluminum, and phosphate).[24] Dehydration was also avoided in the first 10 minutes of chemical reaction by means of using glass plates on the samples, which prevented direct contact between the material and the air, in addition to making the surfaces smooth and uniform.

Total surface hardness of glass-ionomer cements is achieved nearly 24 hours after application and the testing procedures are usually carried out within this period of time to investigate the effects of storage on the cement properties.[23,25,26] As glass-ionomer cement is susceptible to humidity, it is recommended that its surface be coated during the initial curing phase, that is, soon after loosing its surface brightness.[10,18] However, glass-ionomer cements have a slow curing process and during this phase, they are susceptible to saliva and water attacks, which dissolve such materials.[27]

Water plays a crucial role during the curing phase of glass-ionomer cements. First, it serves as a reaction medium and then it slowly hydrates the cross-linked matrix, allowing formation of a stable gel structure which is more resistant and also less susceptible to humidity. If the newly-used cement is exposed to the environment with no protective layer, its surface will show cracks and fissures caused by dehydration. Both dehydration and excess humidity can damage the integrity of the material.[26,28]

If no protection is provided, the material surface will inevitably become porous and cracked, as observed in the non-varnished samples (subgroups A1, B1 and C1). This result can be explained by the nature of the material, because glass-ionomer cements, even when reinforced with composites, react in a more sensitive manner to moistness and abrasion.[29]

Since water balance is crucial to form a stable matrix, and, consequently, to cement maturation, surface protection is extremely important during the initial setting. Thus, due to the fact that glass-ionomer cements exhibit a high degree of solubility and disintegration in the oral environment, protecting the material surface, characterized by its rugosity, is essential to prevent degradation and avoid *S. mutans* colonization.[17,30]

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Protecting the surface of glass-ionomer cement is a process that lasts for at least 1 hour, although the ideal time required to increase resistance to disintegration is 24 hours.[31] It is known, however, that in the oral environment, protective materials are lost within the first 24 hours because of friction.[17] That is the reason why in the methodology used for this study, Cavitine varnish was able to protect the surfaces of the materials within 24 hours.

Although varnishes are indicated as surface protection materials for cements,[13,32] there are reports in the literature in which the evaporation of the varnish solvent is associated with protective films with faulty lines, which does not ensure adequate protection.[17] On the other hand, according to the manufacturer's specifications and the results of this study, Cavitine varnish can be used in orthodontic practice. That is because it proved to be efficient with regard to protection, specially for cementation, since only a small amount of material is actually exposed to the oral environment when a correct adaptation of the band is achieved.

Subgroups A2, B2, and C2 (varnished with Cavitine) had the highest microhardness values. Among the commercially available materials assessed, Ketak-Cem proved to have the highest microhardness values, as previously observed.[33] Additionally, no statistically significant differences were observed in the microhardness values of the non-varnished samples. Therefore, surface protection of glass-ionomer cements during the initial curing phase was found to be useful.

Considering the complexity of the oral environment, preserving the integrity of the material is necessary,[30] since failures in cement bands may lead to tooth demineralization and delay treatment due to the need for recementation. Selecting appropriate materials and caring for their preservation is of professional responsibility, in view of the longevity of orthodontic treatments and commitment to patient health.

CONCLUSION

Protecting the surface of glass-ionomer cements with varnish during the initial curing phase promoted higher microhardness values 24 hours after its application, corroborating the fact that adequate cement preservation is necessary to avoid enamel decalcification. In addition, further clinical comparative studies are required to assess orthodontic bands cemented with either varnished or non-varnished glass-ionomer cements.

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Comparative study on direct and indirect bracket bonding techniques regarding time length and bracket detachment

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Objective: The aim of this study was to assess the time spent for direct (DBB - direct bracket bonding) and indirect (IBB - indirect bracket bonding) bracket bonding techniques. The time length of laboratorial (IBB) and clinical steps (DBB and IBB) as well as the prevalence of loose bracket after a 24-week follow-up were evaluated.

Methods: Seventeen patients (7 men and 10 women) with a mean age of 21 years, requiring orthodontic treatment were selected for this study. A total of 304 brackets were used (151 DBB and 153 IBB). The same bracket type and bonding material were used in both groups. Data were submitted to statistical analysis by Wilcoxon non-parametric test at 5% level of significance.

Results: Considering the total time length, the IBB technique was more time-consuming than the DBB ($p < 0.001$). However, considering only the clinical phase, the IBB took less time than the DBB ($p < 0.001$). There was no significant difference ($p = 0.910$) for the time spent during laboratorial positioning of the brackets and clinical session for IBB in comparison to the clinical procedure for DBB. Additionally, no difference was found as for the prevalence of loose bracket between both groups.

Conclusion: the IBB can be suggested as a valid clinical procedure since the clinical session was faster and the total time spent for laboratorial positioning of the brackets and clinical procedure was similar to that of DBB. In addition, both approaches resulted in similar frequency of loose bracket.

Keywords: Corrective orthodontics. Orthodontic brackets. Dental bonding. Dental detachment.

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

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INTRODUCTION

Bonding accessories on tooth surface revolutionized Orthodontics,making the clinical results easier and more reliable. It solved some of the difficulties encountered in orthodontic banding procedures; such as professional skills, patient's discomfort resulting from separators and banding, risk to periodontal diseases and cavities, better esthetic acceptance, material cost and the time spent to make and insert the bands.[1,2,3] Thus, directly bonding accessories on the enamel became the most common technique used by orthodontists considering that effective bracket bonding is essential for appropriate orthodontic mechanics. This approach also reduces treatment length and avoids rebonding caused by inappropriate positioning and/or loose bracket.[4] On the other hand, precise bracket bonding relies on the professional's experience and accuracy of bonding procedures.

Aiming at improving precision and attaining excellence in orthodontic procedures, Silverman et al[5] developed the indirect bracket bonding (IBB) technique. In this approach, the brackets are previously positioned on casts with water-soluble or intermediary adhesives, and then transferred to the mouth by means of an individual tray. For these authors, the direct bracket bonding (DBB) technique is time-consuming and the correct positioning of the brackets is difficult to achieve clinically.

Thus, the aim of this *in vivo* study was to compare the direct and indirect (tray transferred with fusible glue[6]) bracket bonding techniques regarding the time spent for laboratorial (IBB) and clinical (IBB and DBB) steps and its correlation for the IBB as well as the prevalence of loose bracket.

MATERIAL AND METHODS

Patient selection and study design

Seventeen patients (7 men and 10 women) with a mean age of 21 years, who required orthodontic treatment, were selected for the present prospective study conducted at the college of Dentistry of Paulista University - UNIP/SP from March to June, 2008. Treatment lasted for 2 years. Each subject signed a written informed consent before entering the cohort which was approved by the Paulista University-UNIP/SP Institutional Review board (number 122/05 CEP/ICS/UNIP).

Upper and lower dental casts of each patient were obtained after impression with irreversible hydrocolloid (Jeltrate, Dentsply, Brazil) manipulated according to the manufacturer's instructions. The impressions were rinsed with water for 1 minute, air-dried and then poured with dental stone (Dentsply, Brazil). After stone crystallization (40 minutes), the casts were removed from the impression trays and trimmed. The IBB technique requires working casts with minor irregularities.

Laboratorial step – Fabrication of transferring trays

All laboratorial procedures were conducted by the same operator according to an accurate methodology. Table 1 presents all the acronyms used in this study for laboratorial and clinical steps timings.

The tooth long axis and the gingival-occlusal height of the brackets tubes were determined manually in all patients for correct bracket positioning. The time spent during this procedure was measured by the software Palmaryclock® v. 23 (Palmarysoft 2002-2004) downloaded into Palm Tungsten T device (Palm® - Brazil) and recorded (TL1 – Time spent to determine the height and tooth long axis in the maxilla and mandible during laboratorial step).

The study by Aguirre et al[7] was used as reference to determine the protocol for the IBB technique conducted in the present study. The arches were divided into two sections: upper and lower right side (DBB) and upper and lower left side (IBB), and these sides were chosen based on the fact that they enabled direct visualization of bracket bonding, since a right-handed operator conducted the research by himself. The bonding procedure was initiated at the left central incisor and finished at the left second premolar in both the maxilla and mandible. Water-soluble glue was used and any excess material draining from the brackets base was removed. The Morelli® (0.018 x 0.030-in, Bioprogressive technique) metallic brackets were selected for treating all patients.

The time spent for bonding the brackets on the working casts was also measured and recorded (TL2, time spent for bonding the brackets in maxillary and mandibular casts). However, the time spent for clinical bonding was measured for each tooth individually and then summed up to obtain the total time for

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Table 1 - Acronyms used for different laboratorial and clinical time

TL1	Time spent to determine the height and tooth long axis during laboratorial step in maxilla and mandible
TL2	Time spent for bracket bonding in the cast in maxilla and mandible
TL3	Time spent for fabrication of transferring trays in maxilla and mandible
TLt	Total laboratorial time in maxilla and mandible
TCI1	Time spent with IBB during clinical step in maxilla and mandible
TCI2	Time spent for removal and cleaning of the IBB area in maxilla and mandible
TCIt	Total clinical time for IBB in maxilla and mandible
TCD1	Time spent with DBB in maxilla and mandible
TCD2	Time spent for cleaning of the DBB area in maxilla and mandible
TCDt	Total time for DBB in maxilla and mandible
TPBt	Time spent for laboratorial positioning of the brackets

bonding performed in each hemi-arch. To make the transferring tray (Figs 1 and 2),hot melt adhesive (slightly fluid) was applied to each bracket and to the vestibular surface of each tooth, following the same bonding sequence for the model, in other words, the bonding started from tooth #21 to #25, then from #31 up to #35. After that, additional glue was inserted on the incisal and occlusal surfaces of the teeth in order to make a less flexible and harder tray. The time spent for making the transferring trays was also measured and recorded (TL3, time spent for fabrication of the upper and lower transferring trays).

After solidification of the silicone glue (hot melt glue), the casts were hydrated for 1 minute so that the glue could be dissolved and, then, the brackets were transferred with the transferring trays, concluding the laboratorial step of the IBB approach. The total laboratorial time included the time spent for bracket bonding and fabrication/cleaning of the transferring trays (TLt – total laboratorial time for maxilla and mandible), which means that TLt=TL1+TL2+TL3.

Clinical step

The IBB technique was conducted at the upper and lower left side while the right side was selected for the DBB technique (Fig 3). The procedure was timed after prophylaxis (pumice and rubber tip) and enamel etching performed with 37% of phosphoric acid (RMO) following the manufacturer's instructions since the time spent for this initial step was similar for both techniques. The self-curing resin (paste + liquid – No Mix) Mono Lock 2 (RMO®) was selected for bonding.

For IBB, the etched teeth and transferring trays were dried in order to maintain the chemical and physical properties of the adhesive system. Then, the activator of the bonding material (liquid) was applied on the enamel and brackets mesh positioned into the transferring tray. After that, resin (paste) was inserted on the brackets mesh that was positioned at the hemi-arch of the patient.

The whole process from application of the activator (liquid) on enamel to positioning of the transferring tray



Figure 1 - Fabrication of the transferring tray.

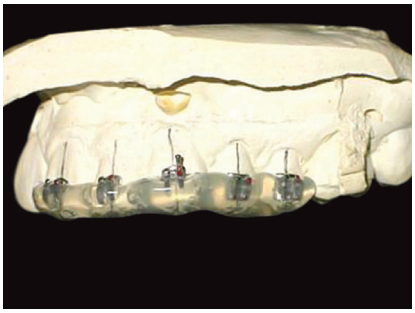


Figure 2 - Transferring trays with ideal dimension and thickness.



Figure 3 - Example of brackets bonded by means of DBB and IBB techniques in the maxilla

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was timed and recorded (TCI1 – time spent for clinical session of IBB technique in maxilla and mandible).

The DBB approach was conducted in sequence, from the right central incisor to the right second premolar in both jaws. The whole process of the direct technique was timed (TCD1 – time spent with the DBB technique in maxilla and mandible). The bonding steps were similar to those of the IBB approach: Drying of the etched teeth, application of activator on enamel and bracket mesh, insertion of resin on brackets mesh, and positioning it on the teeth. The positioning respected the height of each tooth (Boone bracket positioning gauge).

After DBB, the removal and cleaning of the IBB area was conducted. The transferring tray and the excess resin were removed using the tip of the rubber band insertion tool and a bur for enamel (3M Unitek – California), respectively. This step was also timed and recorded (TCI2 – time spent for removal and cleaning of the IBB area in maxilla and mandible).

The total clinical time for the IBB approach was represented by the time spent for IBB and cleaning step (TCIt – total clinical time spent for IBB technique in maxilla and mandible), which means TCIt = TCI1+TCI2.

The cleaning of the DBB area was also conducted using a bur to remove excess resin on the enamel surface (3M Unitek – California). This process was also timed and recorded (TCD2 – time spent for cleaning of the DBB area in maxilla and mandible).

The total clinical time for the DBB approach was represented by the time spent for DBB (tooth by tooth) and cleaning step (TCDt – total clinical time spent for DBB technique in maxilla and mandible), which means TCDt = TCD1+TCD2.

After the clinical step, the patient was submitted to correction of dental positioning through orthodontic mechanics.

Follow-up

The patients were evaluated every 4 weeks in order to have the loose brackets assessed. A 24-week follow-up was accomplished, representing 6 monthly appointments. All detachments were noted on each patient's record taking into account the side (right and left), arch (maxilla and mandible), date (day/month/year), and position (tooth). The loose brackets were replaced by new brackets bonded according to the DBB technique.

Statistical analysis

The Wilcoxon non-parametric test was applied for comparison between the periods, since assumption of data normality was rejected. A significance level of 5% was used in all tests.

RESULTS

Based on the statistical analysis carried out, the following results were obtained.

Evaluation of time spent for bracket bonding with DBB and IBB techniques

Considering the total time spent with IBB (TLt+TCIt) and DBB (TCDt) in both jaws, the Wilcoxon test revealed significant difference ($p < 0.001$) between the groups, which means that IBB was more time-consuming than DBB (Table 2 and Fig 4). However, when only the clinical step was considered, a statistically significant difference ($p < 0.001$) was also observed, but IBB (TCIt) was less time-consuming than DBB (TCDt) (Table 3 and Fig 5).

There was no significant difference ($p = 0.910$) for the time spent during laboratorial positioning of the brackets (TPBt = TL1+TL2) and clinical step with IBB (TCIt) in comparison to the clinical time with DBB (TCDt) (Table 4 and Fig 6).

Total number of brackets detached with IBB and DBB techniques

After bracket bonding performed with IBB and DBB approaches in both jaws, a 24-week follow-up was conducted for all patients in order to check potential loose bracket. A total of 304 brackets were inserted, including 151 brackets with DBB technique (70 brackets in maxilla and 81 in mandible) and 153 brackets with IBB (72 brackets in maxilla and 81 in mandible). At the end, a total of 18 brackets were detached, which represents 5.92% (Table 5 and Fig 7).

Maxilla exhibited a lower number of loose brackets (22.22%) in comparison to the mandible (77.78%), including 4 detachments in the upper arch (3 for IBB and 1 for DBB) and 14 occurrences in the lower arch (8 for IBB and 6 for DBB).

DISCUSSION

The results of the present study demonstrated that the total time spent with the IBB technique (laboratorial

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Table 2 - Total time spent with IBB (TLt+TCIt) and DBB (TCDt), in both arches.

Time	n	Mean ± SD	Minimum	Maximum	Median
IBB (TLt+TCIt)	17	1167,20 ± 239,39	961	1913	1092,00
DBB (TCDt)	17	892,73 ± 116,21	646	1057	914,00

Time in seconds.

Table 3 - Total time spent with IBB (TLt+TCIt) and DBB (TCDt) in both arches, for clinical steps.

Time	n	Mean ± SD	Minimum	Maximum	Median
IBB (TCIt)	17	380,13 ± 47,59	315	489	376,00
DBB (TCDt)	17	892,73 ± 116,21	646	1057	914,00

Time in seconds.

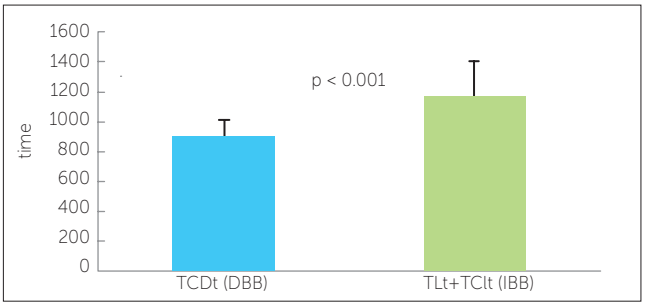


Figure 4 - Comparison of the time spent with IBB (TLt+TCIt) and DBB (TCDt) in the maxilla and the mandible.

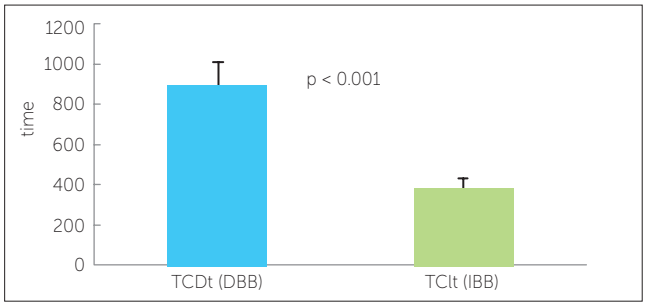


Figure 5 - Comparison of the time spent with IBB (TCIt) and DBB (TCDt) in the maxilla and the mandible during clinical step.

Table 4 - Total time spent for laboratorial and clinical steps with IBB (TPBt+TCIt) and DBB (TCDt).

Time	n	Mean ± SD	Minimum	Maximum	Median
IBB (TPBt+TCIt)	17	885,87 ± 149,31	720	1296	842,00
DBB (TCDt)	17	892,73 ± 116,21	646	1057	914,00

Time in seconds

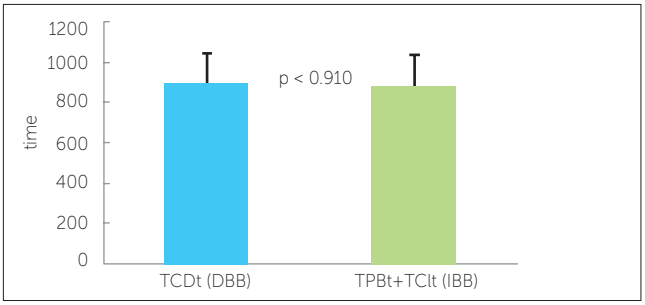


Figure 6 - Comparison of the time spent during laboratorial and clinical steps with IBB (TPBt+TCIt) and DBB (TCDt).

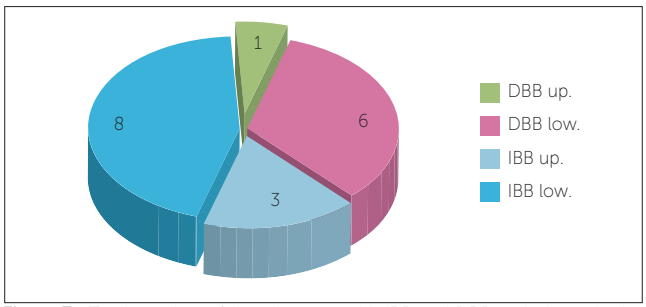


Figure 7 - Total number of detachments with IBB and DBB techniques in the maxilla and the mandible.

Table 5 - Distribution of the total number of loose brackets in maxilla and mandible regarding time and teeth.

Technique	tooth	Months 1	2	3	4	5	6	Detachment
IBB	25							0
	24					1		1
	23					1		1
	22							0
	21			1				1
DBB	11							0
	12					1		1
	13							0
	14							0
	15							0
IBB	35	1						1
	34	1						1
	33	2						2
	32	1						1
	31	2	1					3
DBB	41				1			1
	42			1				1
	43	2						2
	44							0
	45				1		1	2
Detach.		9	1	2	2	3	1	18

and clinical steps) was significantly longer than that with the DBB approach, which is in agreement with other authors[3,6-9]. The mean total time for IBB (TLt+TCIt) was 1167.20 seconds, nearly 19.46 minutes to conclude the process from the central incisor to the second premolar at the left side (maxilla and mandible). If this value were doubled, a total of 38.92 minutes would be spent to complete de IBB procedure in the whole mouth.

As for the DBB technique, a mean time of 892.73 seconds was used to complete the process (TCDt), nearly 14.88 minutes for bonding from the central incisor to the second premolar at the right side (maxilla and mandible). Again, if this value were double, a total of 29.76 minutes would be necessary to accomplish the DBB procedure in the whole mouth.

Thus, the time spent with both IBB and DBB techniques in the present study was shorter than that reported by other researches.[7,9] In this sense, the IBB procedure can be considered faster due to being considered as an easy technique, demanding fewer laboratorial steps and being clinically applied with ease.

With regard to the clinical phase, the present study revealed that the IBB technique was significantly less time-consuming than the DBB.[8-11] A mean of 380.13 seconds was necessary to complete the clinical procedure with the IBB (TCIt), representing about 6.33 minutes. Thus, based on the same analogy described previously, the procedure would be completed in 12.68 minutes for the whole mouth. Considering that the total time (laboratorial and clinical steps) for both jaws (maxilla and mandible) was 38.92 minutes, the laboratorial phase represents 67.50% of the IBB technique. However, trained assistants could carry out some of these procedures (fabrication and cleaning of the transferring tray), reducing the difference between IBB and DBB approaches.[11]

As for DBB, the mean total time in both jaws was 29.76 minutes, longer than time used to perform the clinical step with IBB (12.68 minutes). Thus, the IBB is advantageous in comparison to the DBB since it reduces chair-time for bracket bonding, minimizes clinical stress and increases patient's comfort.[11]

It is important to highlight that the time spent to make the working casts was not considered since it can be obtained at the same session in which diagnostic casts are made or even at a dental radiology center. However, the other laboratorial steps could not be disregarded.

As for loose brackets, the results demonstrated a value of 5.92% during a 24-week follow-up, which was similar to previous studies.[7,9,12-13] It has been suggested that there is no statistically significant difference between the IBB and DBB techniques regarding the retention of brackets bonded to human enamel.[14,15,16]

In this sense, the lower teeth exhibited more failures than the upper teeth.[7,17,18,19] However, the anterior teeth presented more detachments in comparison to the posterior teeth, which is in disagreement with other studies.[17-20] Considering the analysis of the results and the clinical aspects that could result in a higher prevalence of failure in the lower anterior teeth, it was concluded that this data was specific for the present sample. The loose brackets may have been caused by failure during initial impression or positioning (DBB), failure during laboratorial step (IBB), poor tooth polishing, failure during acid etching, poor control of humidity, several contaminations (saliva and blood), improper occlusion (contact with orthodontic accessories), repeated trauma (hard food), and enamel quality.[21]

Considering the literature and the present results, it was observed that the IBB technique is advantageous in comparison to the DBB approach due to easy laboratorial procedure, accurate brackets positioning, reduced chair-time and clinical stress, and multidisciplinary accomplishment (orthodontist and assistants).

CONCLUSIONS

The total time spent with the DBB technique was shorter than that with the IBB approach. However, the clinical step took less time with IBB in comparison to DBB. The time spent for laboratorial positioning of the brackets and clinical insertion with IBB was similar to that observed with DBB, which justifies the advantages of the IBB technique in comparison to the DBB procedure.

Both approaches (IBB and DBB) exhibited similar prevalence of loose bracket and the highest number of failures occurred in the lower jaw.

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Comparative cephalometric study of Class II malocclusion treatment with Pendulum and Jones jig appliances followed by fixed corrective orthodontics

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Objective: The purpose of this study was to cephalometrically compare the skeletal and dentoalveolar effects in the treatment of Class II malocclusion with Pendulum and Jones jig appliances, followed by fixed corrective orthodontics, and to compare such effects to a control group.

Methods: The sample was divided into three groups. Group 1: 18 patients treated with Pendulum, Group 2: 25 patients treated with Jones jig, and Group 3: 19 young subjects with untreated Class II malocclusions and initial mean age of 12.88 years. The chi-square test was applied to assess severity and gender distribution. Groups 1 and 2 were compared to the control group by means of the one-way ANOVA and Tukey tests in order to differentiate treatment changes from those occurred by craniofacial growth.

Results: There were no significant changes among the three groups with regard to the components of the maxilla and the mandible, maxillomandibular relationship, cephalometric and tegumental pattern. Buccal tipping of mandibular incisors was significantly greater in the experimental groups and increased mesial angulation of the maxillary second molars was found in the Jones jig group. In the experimental groups, dental relationship, overbite and overjet were corrected.

Conclusion: It can be stated that the distalization achieved its purpose of correcting the Class II.

Keywords: Angle Class II malocclusion. Corrective orthodontics. Molar tooth.

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INTRODUCTION

Intraoral distalizers differ in terms of insertion site,[4] mechanism of action and anchorage reinforcement.[15] The Jones jig appliance is inserted buccally and acts through a nickel titanium spring anchored in the second premolars.[14] The Pendulum appliance is palatally positioned, anchored in the first and second premolars and its force is dissipated through TMA springs.[12]

The intraoral distalization performed with fixed intraoral devices is only the first phase of a treatment that will be finalized with fixed corrective mechanics. There are few studies in the literature that scientifically assess the results of both phases of treatment;[3,6,7,20] most studies only assess the results of distalization.[9,10,12,15,16,17,21] Therefore, it is essential to perform a study assessing and comparing the results of corrective orthodontic treatment initiated by intraoral maxillary molar distalization with different intraoral distalization appliances.

MATERIAL AND METHODS

Initially, the research project was evaluated and approved by the College of Dentistry – Bauru/ University of São Paulo (USP) Institutional Review Board .

Three groups with Class II malocclusion were compared: Group 1: comprised 18 patients (initial mean age of 13.92 years), 6 males and 12 females. A normal molar relationship was obtained from maxillary molar distalization performed with the Pendulum appliance and maintained by the nightly use of cervical headgear (KHG) associated with corrective fixed appliances. The mean treatment time was 4.55 years (Table 1). Group 2: comprised 25 patients (initial mean age of 12.09 years), 14 males and 11 females. Class II correction was achieved with the Jones jig appliance and maintained by the nightly use of medium-high headgear traction (helmet jeans), during corrective orthodontic treatment. The mean duration of orthodontic treatment was 4.09 years (Table 1).

Group 3: comprised 19 young subjects with untreated Class II malocclusion (control group), 10 males and 9 females (initial mean age of 12.88 years) and followed up for a mean period of 3.71 years (Table 1). This sample was selected from a group of young subjects that had been annually radiographed and accompanied by the Department of Orthodontics, School of Dentistry – Bauru/ University of São Paulo (USP). All patients had been referred for orthodontic treatment, however, some of them opted for late intervention and others had no interest in the treatment.

The cephalometric variables analyzed were based on the orthodontic literature[3,6,8,11,22] and aimed at promoting a comparative study, allowing discussion of the results obtained (Fig 1).

At first, chi-square tests were used to assess severity and gender distribution (Tables 2 and 3). The three groups were assessed and cephalometrically compared in order to observe the effects of orthodontic treatment and to differentiate them in terms of the changes promoted by craniofacial growth and development (Fig 1). Thus, one-way ANOVA and Tukey tests were used.

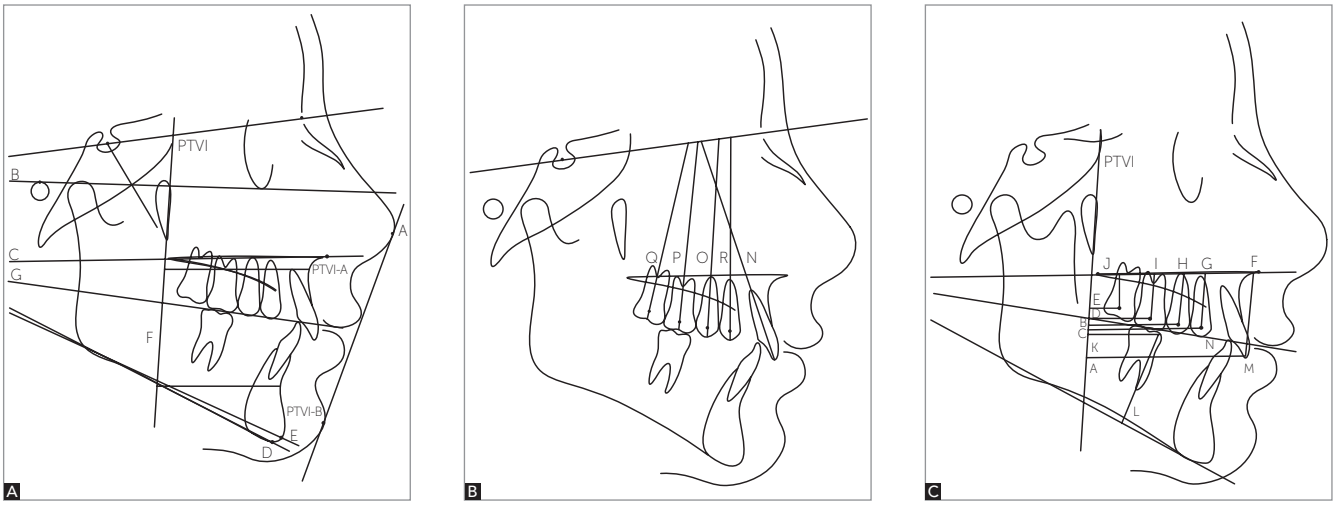


Figure 1 - **A**) Lines and Planes: A = Line E; B = Frankfort Plane; C = Palatal Plane; D = Mandibular Plane (Go-Me); E = Mandibular Plane (Go-Gn); F = Pterygoid vertical line (PTVI); G = Occlusal Plane; **B)** Dental angular measurements: N = SN.1; R = SN.4; O = SN.5; P = SN.6; Q = SN.7. **C)** Dental linear measurements: A = PTVI-1; B = PTVI-4; C = PTVI-5; D = PTVI-6; E = PTVI-7; F, = PP-1; G, = PP-4; H = PP-5; I = PP-6; J = PP-7; K = PTVI- ; L = GoMe - , M = Overjet; N = Overbite.

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Table 1 - Compatibility of the mean initial and final ages as well as the observation mean time of the young patients in the three groups (ANOVA).

VARIABLE (Y)	Group 1 (Pendulum) N = 18		Group 2 (Jones jig) N = 25		Group 3 (Control) N = 19		P
	Mean ± SD		Mean ± SD		Mean ± SD		
Pretreatment age	13.92[A]	1.71	12.90[A]	1.43	12.88[A]	1.47	0.063
Posttreatment age	18.48[A]	1.33	16.99[B]	1.87	16.60[B]	2.31	0.008*
Observation time (T_3 -T_1)	4.55[A]	0.79	4.09[A]	0.99	3.71[A]	1.63	0.110

* Statistically significant for P < 0.05
Different letters stand for statistically significant difference.

Table 2 - Number of female and male subjects for each group and result of the chi-square test.

Group	Sex		Total
	Male	Female	
1 – Pendulum	6 (33.3%)	12 (66.7%)	18
2 – Jones jig	14 (56%)	11 (44%)	25
3 – Control	10 (52.6%)	9 (47.4%)	19
Total	30	32	62
χ^2 = 2.35; gl = 2; P = 0.3087			

* Statistically significant difference for P < 0.05
Different letters stand for statistically significant difference.

Table 3 - Comparison of Class II malocclusion severity among groups and chi-square test results.

Group	Molar relationship				Total
	¼ Class II	½ Class II	¾ Class II	Full-cusp Class II	
1 – Pendulum	1 (5.6%)	7 (38.8%)	5 (27.8%)	5 (27.8%)	18
2 – Jones jig	11 (44%)	7 (28%)	3 (12%)	4 (16%)	25
3 – Control	9 (47.4%)	5 (26.3%)	3 (15.8%)	2 (10.5%)	19
Total	21	19	11	11	62
χ^2 = 9.76; gl=6; P = 0.1350					

* Statistically significant difference for P < 0.05
Different letters stand for statistically significant difference.

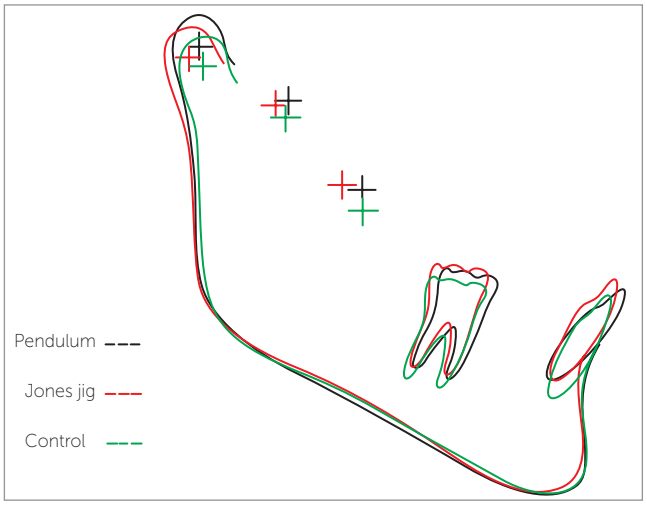


Figure 2 - Comparison between Pendulum and Jones jig appliances and the control group.

RESULTS

Initially, the groups were compared in order to quantify any potential differences existing prior to orthodontic treatment. Out of the 43 variables analyzed, only 10 presented statistically significant differences, demonstrating that the sample had approximately 77% of initial cephalometric compatibility (Table 4).

Changes during treatment as well as changes occurring during the growth and development period were obtained by means of establishing the difference between treated patients' initial and final mean values. Table 4 shows the results of one-way ANOVA and Tukey tests performed among the initial cephalometric measurements mean values of the three groups.

The components related to the maxilla, mandible, maxillomandibular relationship, vertical pattern and soft tissue did not present statistically significant differences (Table 5).

Greater mesial movement of maxillary second molars was observed in the Jones jig group. Buccal tipping of mandibular incisors was greater in the Pendulum group than in the control group. Additionally, greater protrusion of these incisors was observed in the experimental groups (Fig 2). The mandibular first molars showed similar mesial movement for all the three groups; however, greater extrusion was observed in the Jones jig group when compared to the Pendulum and control groups (Table 5).

There was a significant difference in molar relationship, with a significant change for the experimental groups, which resulted in correction of the Class II. Conversely, the initial malocclusion remained in the control group (Table 5).

DISCUSSION

There are few comparatives studies assessing the first (maxillary molars distalization) and the second phase of treatment (corrective orthodontic treatment).[3,6,7,8] Thus, the aim of this study was to compare the changes at the end of the corrective orthodontic treatment, which was initialized by the distalization of the maxillary molars by two different intraoral distalization appliances. Additionally, it compared such changes to the control group.

Assessment of the characteristics related to the groups proved that there was compatibility in terms of initial age and treatment/observation times. On the other hand, the final age was statistically and

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Table 4 - ANOVA and Tukey test results: means and standard deviation of initial cephalometric measurements mean values taken to assess compatibility among groups as well as values of the significance probability level (P) - (T_1).

Variable	Group 1 (Pendulum) n = 18	Group 2 (Jones Jig) n = 25	Group 3 (Control) n= 19	p
Maxillary Component (Mean ± SD)				
SNA (degrees)	83.13 ± 3.34^{A}	82.35 ± 4.13^{A}	81.14 ± 2.51^{A}	0.223
Co-A (mm)	86.66 ± 4.53^{A}	82.10 ± 4.86^{B}	81.68 ± 5.05^{B}	0.003*
PTVI-A (mm)	49.98 ± 2.34^{A}	47.82 ± 4.17^{A}	47.91 ± 3.03^{A}	0.090
Mandibular Component (Mean ± SD)				
SNB (degrees)	78.84 ± 2.77^{A}	78.82 ± 3.09^{A}	78.20 ± 2.01^{A}	0.702
Co-Gn (mm)	108.13 ± 4.50^{A}	104.86 ± 5.07^{AB}	102.72 ± 5.17^{B}	0.005*
P-NB (mm)	2.25 ± 1.76^{A}	1.56 ± 1.28^{A}	1.94 ± 1.21^{A}	0.283
PTVI-B (mm)	47.70 ± 3.04^{A}	46.87 ± 5.47^{A}	47.41 ± 4.55^{A}	0.833
Maxillomandibular Relationship (Mean ± SD)				
ANB (degrees)	4.28 ± 1.36^{A}	3.53 ± 3.08^{A}	2.94 ± 2.18^{A}	0.251
NAP (degrees)	6.29 ± 3.23^{A}	5.50 ± 7.12^{A}	4.06 ± 5.33^{A}	0.482
Vertical Component (Mean ± SD)				
FMA (degrees)	28.17 ± 5.14^{A}	29.87 ± 4.43^{A}	27.00 ± 3.20^{A}	0.096
SN.PP (degrees)	6.07 ± 3.54^{A}	6.22 ± 3.98^{A}	7.29 ± 3.15^{A}	0.522
SN.GoGn (degrees)	29.64 ± 5.17^{A}	31.54 ± 4.05^{A}	29.89 ± 3.34^{A}	0.273
SN.GoMe (degrees)	33.06 ± 5.28^{A}	34.64 ± 4.13^{A}	32.85 ± 3.12^{A}	0.309
NS.Gn (degrees)	65.30 ± 3.00^{A}	66.26 ± 3.61^{A}	65.40 ± 2.23^{A}	0.516
Occlusal plane (degrees)	8.51 ± 3.79^{A}	9.77 ± 4.13^{A}	9.54 ± 3.07^{A}	0.535
LAFH (mm)	62.31 ± 3.78^{A}	61.81 ± 5.19^{A}	58.37 ± 3.30^{B}	0.011*
Maxillary Dentoalveolar Component (Mean ± SD)				
SN.1 (degrees)	103.04 ± 6.60^{A}	107.84 ± 5.90^{B}	104.66 ± 4.96^{AB}	0.028*
PTVI-1 (mm)	55.96 ± 2.77^{A}	55.44 ± 4.95^{A}	54.71 ± 3.24^{A}	0.623
PP-1 (mm)	27.41 ± 2.29^{A}	26.87 ± 2.74^{A}	25.81 ± 2.01^{A}	0.127
1.NA (degrees)	19.89 ± 5.81^{A}	25.48 ± 6.09^{B}	23.72 ± 5.50^{AB}	0.011*
1-NA (mm)	3.29 ± 2.03^{A}	4.94 ± 2.86^{A}	4.50 ± 2.31^{A}	0.101
SN.4 (degrees)	81.29 ± 4.07^{A}	82.76 ± 4.99^{A}	80.06 ± 4.09^{A}	0.145
PTVI-4 (mm)	38.04 ± 2.28^{A}	36.20 ± 3.74^{AB}	35.16 ± 3.20^{B}	0.028*
PP-4 (mm)	19.28 ± 2.30^{A}	19.09 ± 2.42^{A}	18.31 ± 1.85^{A}	0.363
SN.5 (degrees)	79.33 ± 3.12^{A}	78.49 ± 5.46^{A}	77.99 ± 4.07^{A}	0.655
PTVI-5 (mm)	31.58 ± 2.42^{A}	29.80 ± 3.71^{A}	29.01 ± 3.32^{A}	0.056
PP-5 (mm)	18.81 ± 2.28^{A}	18.67 ± 2.42^{A}	17.60 ± 1.67^{A}	0.175
SN.6 (degrees)	66.70 ± 2.84^{A}	65.70 ± 4.65^{A}	66.98 ± 4.48^{A}	0.645
PTVI-6 (mm)	23.29 ± 2.37^{A}	21.68 ± 3.61^{A}	20.93 ± 3.59^{A}	0.092
PP-6 (mm)	17.10 ± 2.31^{A}	16.84 ± 2.27^{A}	15.72 ± 1.53^{A}	0.103
SN.7 (degrees)	52.96 ± 5.64^{AB}	50.92 ± 6.31^{B}	56.65 ± 5.02^{A}	0.007*
PTVI-7 (mm)	13.29 ± 2.36^{A}	11.98 ± 3.02^{A}	11.71 ± 3.05^{A}	0.201
PP-7 (mm)	13.57 ± 2.36^{A}	11.37 ± 3.76^{AB}	10.29 ± 3.01^{B}	0.009*
Mandibular Dentoalveolar Component (Mean ± SD)				
1.NB (degrees)	26.53 ± 4.64^{A}	25.64 ± 5.99^{A}	24.41 ± 4.50^{A}	0.463
1-NB (mm)	3.94 ± 2.07^{A}	4.45 ± 2.20^{A}	3.37 ± 1.39^{A}	0.198
PTVI- (mm)	22.22 ± 3.78^{A}	20.99 ± 4.27^{A}	21.28 ± 4.05^{A}	0.611
GoMe- (mm)	28.18 ± 2.01^{A}	27.69 ± 2.62^{A}	26.63 ± 2.10^{A}	0.117
Soft Tissue (Mean ± SD)				
NLA (degrees)	107.06 ± 11.07^{AB}	103.13 ± 10.35^{A}	114.09 ± 11.11^{B}	0.005*
E-Ls (mm)	2.38 ± 2.19^{A}	2.05 ± 2.71^{A}	2.68 ± 2.07^{A}	0.683
E-Li (mm)	1.46 ± 3.05^{A}	0.06 ± 2.38^{A}	1.14 ± 1.88^{A}	0.151
Dental Relationships (Mean ± SD)				
Molar Relationship (mm)	0.03 ± 1.17^{A}	-0.42 ± 1.02^{AB}	-0.93 ± 0.74^{B}	0.016*
Overjet (mm)	4.43 ± 1.15^{A}	4.67 ± 1.55^{A}	4.48 ± 1.95^{A}	0.867
Overbite (mm)	5.00 ± 1.70^{A}	3.92 ± 1.48^{A}	4.04 ± 1.53^{A}	0.069

* Statistically significant difference for $P < 0.05$.
Different letters stand for statistically significant difference.

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Table 5 - ANOVA and Tukey test results: means and standard deviation of cephalometric measurements means.(ANOVA – T_3-T_1)

Variable	Group 1 (Pendulum) n = 18	Group 2 (Jones Jig) n = 25	Group 3 (Control) n = 19	P
Maxillary Component (Mean ± SD)				
SNA (degrees)	-1.07 ± 1.75^{A}	0.02 ± 1.85^{A}	-0.67 ± 3.43^{A}	0.329
Co-A (mm)	1.22 ± 3.27^{A}	1.41 ± 3.59^{A}	3.20 ± 3.43^{A}	0.151
PTVI-A (mm)	0.73 ± 2.40^{A}	1.15 ± 2.29^{A}	1.08 ± 3.62^{A}	0.878
Mandibular Component (Mean ± SD)				
SNB (degrees)	-0.26 ± 1.73^{A}	0.74 ± 2.28^{A}	-0.35 ± 2.24^{A}	0.169
Co-Gn (mm)	4.77 ± 5.82^{A}	5.98 ± 4.21^{A}	4.92 ± 3.31^{A}	0.626
P-NB (mm)	0.61 ± 0.98^{A}	0.46 ± 0.84^{A}	0.25 ± 0.81^{A}	0.473
PTVI-B (mm)	1.36 ± 3.62^{A}	2.03 ± 2.70^{A}	1.69 ± 5.09^{A}	0.851
Maxillomandibular Relationship (Mean ± SD)				
ANB (degrees)	-0.81 ± 2.02^{A}	-0.72 ± 2.19^{A}	-0.11 ± 3.03^{A}	0.796
NAP (degrees)	-2.30 ± 4.68^{A}	-2.00 ± 4.79^{A}	-1.07 ± 6.81^{A}	0.771
Vertical Component (Mean ± SD)				
FMA (degrees)	0.46 ± 2.55^{A}	1.72 ± 2.62^{A}	0.31 ± 4.48^{A}	0.298
SN.PP (degrees)	0.21 ± 1.83^{A}	0.24 ± 3.11^{A}	1.05 ± 3.22^{A}	0.578
SN.GoGn (degrees)	0.46 ± 2.29^{A}	0.23 ± 2.45^{A}	1.16 ± 5.47^{A}	0.689
SN.GoMe (degrees)	0.18 ± 2.14^{A}	0.40 ± 2.20^{A}	1.27 ± 4.89^{A}	0.552
NS.Gn (degrees)	0.93 ± 1.51^{A}	0.63 ± 2.14^{A}	1.40 ± 2.93^{A}	0.541
Occlusal plane (degrees)	-0.05 ± 2.80^{A}	1.70 ± 3.32^{A}	-1.22 ± 5.47^{A}	0.057
LAFH (mm)	3.63 ± 3.01^{A}	5.60 ± 2.82^{A}	3.48 ± 5.38^{A}	0.128
Maxillary Dentoalveolar Component (Mean ± SD)				
SN.1 (degrees)	1.68 ± 7.01^{A}	-1.63 ± 6.65^{A}	-1.87 ± 4.32^{A}	0.147
PTVI-1 (mm)	1.40 ± 3.64^{A}	1.26 ± 3.12^{A}	1.63 ± 4.49^{A}	0.947
PP-1 (mm)	0.58 ± 1.78^{A}	1.68 ± 1.48^{A}	1.07 ± 3.12^{A}	0.273
1.NA (degrees)	2.79 ± 6.63^{A}	-1.63 ± 6.77^{A}	-1.43 ± 4.74^{A}	0.051
1-NA (mm)	0.98 ± 2.40^{A}	0.12 ± 2.55^{A}	-0.18 ± 2.33^{A}	0.322
SN.4 (degrees)	-0.29 ± 5.47^{A}	-1.83 ± 4.69^{A}	0.59 ± 3.23^{A}	0.210
PTVI-4 (mm)	1.24 ± 2.87^{A}	2.20 ± 2.09^{A}	2.10 ± 4.49^{A}	0.587
PP-4 (mm)	1.80 ± 1.41^{A}	2.13 ± 1.24^{A}	1.63 ± 2.81^{A}	0.673
SN.5 (degrees)	-1.43 ± 6.11^{A}	1.76 ± 4.61^{A}	0.06 ± 3.05^{A}	0.095
PTVI-5 (mm)	1.20 ± 2.83^{A}	2.22 ± 2.00^{A}	1.81 ± 4.56^{A}	0.587
PP-5 (mm)	1.86 ± 1.48^{A}	2.10 ± 1.33^{A}	1.95 ± 2.75^{A}	0.915
SN.6 (degrees)	-0.77 ± 6.67^{A}	1.55 ± 4.85^{A}	0.20 ± 5.65^{A}	0.409
PTVI-6 (mm)	0.61 ± 2.68^{A}	1.82 ± 1.89^{A}	1.98 ± 4.60^{A}	0.356
PP-6 (mm)	2.10 ± 1.57^{A}	2.39 ± 1.54^{A}	2.36 ± 3.06^{A}	0.896
SN.7 (degrees)	1.59 ± 6.53^{AB}	5.44 ± 7.31^{A}	-0.76 ± 5.81^{B}	0.010*
PTVI-7 (mm)	0.75 ± 2.73^{A}	1.42 ± 1.91^{A}	1.47 ± 4.00^{A}	0.695
PP-7 (mm)	2.37 ± 2.16^{A}	4.40 ± 2.89^{A}	4.32 ± 3.90^{A}	0.074
Mandibular Dentoalveolar Component (Mean ± SD)				
1.NB (degrees)	6.18 ± 6.72^{A}	2.52 ± 5.56^{AB}	-0.73 ± 3.28^{B}	0.001*
1-NB (mm)	1.70 ± 1.64^{A}	1.41 ± 1.89^{A}	0.06 ± 0.85^{B}	0.004*
PTVI- (mm)	2.27 ± 2.68^{A}	2.83 ± 2.23^{A}	2.42 ± 3.14^{A}	0.774
GoMe- (mm)	2.04 ± 1.60^{A}	3.76 ± 2.37^{B}	1.90 ± 1.85^{A}	0.004*
Soft Tissue (Mean ± SD)				
NLA (degrees)	2.06 ± 9.01^{A}	1.60 ± 7.54^{A}	2.36 ± 8.51^{A}	0.975
E-Ls (mm)	1.56 ± 1.01^{A}	1.91 ± 1.53^{A}	1.03 ± 2.03^{A}	0.199
E-Li (mm)	0.28 ± 1.24^{A}	0.74 ± 1.21^{A}	1.40 ± 2.63^{A}	0.165
Dental Relationships (Mean ± SD)				
Molar relationship (mm)	-2.62 ± 1.29^{A}	-2.36 ± 1.36^{A}	-0.22 ± 1.24^{B}	0.000*
Overjet (mm)	-1.35 ± 1.37^{AB}	-1.90 ± 1.69^{A}	-0.14 ± 2.00^{B}	0.005*
Overbite (mm)	-2.47 ± 1.68^{A}	-1.56 ± 1.51^{A}	-0.13 ± 1.94^{B}	0.000*

* Statistically significant difference for P < 0.05
Different letters stand for statistically significant difference.

significantly different, representing a trend of an older age in group 1. However, most studies in the literature consider compatibility of initial age and treatment time,[2,5] only, which is considered as sufficient to characterize a reliable sample compatibility.[7]

Changes during treatment for the variables of both maxillary and mandibular components were similar among the three groups (Table 5), and improvements in the maxillomandibular relationship were observed. However, this change was more significant in the experimental groups and it is justified by the treatment performed. Conversely, although this improvement was less significant in the control group, it was due to craniofacial growth. The results prove that intraoral distalization appliances do not interfere in craniofacial growth and development.[6,19,21]

Assessment of the vertical skeletal variables in the initial stage, except for the lower anterior face height (LAFH), demonstrates that the measurements showed no statistically significant difference among groups. Changes happening as a result of treatment and growth were statistically similar for the three groups; however, they were numerically higher in the Jones jig group. The different changes for the Jones jig and control groups occurred due to the extrusion of first and second premolars during treatment, in other words, although not significant, extrusion of these teeth was slightly higher in the Jones jig group than in the control group (Table 5).

Results demonstrate that the three groups showed clockwise mandibular rotation, which confirms the downward displacement of the mandible, as observed during the post-distalization stage of several studies.[3,6,7,8,10,21] Assuming that this change occurred as a result of maxillary premolars and molars extrusion due to loss of anchorage and the distalization effect, it is thought that during corrective treatment, correction of extrusions will occur and the rotation will be reversed as a consequence. However, according to Taner-Sarisoy and Darendeliler,[23] most orthodontic mechanics, if not all, are extrusive and this extrusion increases the LAFH during treatment, keeping it increased during the retention period. Moreover, an increase in LAFH due to craniofacial growth and development is common.[18] Therefore, it can be stated that mandibular rotation is related to changes in the distalization phase,[3,8,21] the corrective orthodontic mechanics[23] and craniofacial growth and development.[18]

During the observation period, changes in the nasolabial angle were similar in the three groups. This finding demonstrates that the treatment protocol used does not interfere in the tegumental profile; therefore, the facial characteristics are maintained in the experimental groups.[8]

When assessing the maxillary dentoalveolar component, it was observed that only the maxillary second molars showed significant changes, i.e., at treatment onset, the Jones jig group presented the second molars more distally angulated than the control group, and during treatment, this group also showed a greater mesial angulation in relation to the control group. This initial position can be explained by the difference in the mean initial age that, although not significant, was lower in the Jones jig than in the control group (Table 1); hence, the second molars were more below the occlusal plane, showing a more distal position.

Regarding the positioning of the mandibular incisors, a minor change was observed in the control group, while the Pendulum and Jones jig groups presented greater buccal tipping and protrusion of the mandibular incisors**,** certainly related to the use of Class II rubber bands and overjet correction, which occurred as a consequence of the compensation of the mandibular teeth (Fig 2).

As for the vertical positioning of the mandibular molars, significant extrusion was greater in the Jones jig group than in the Pendulum and control groups. This change was related not only to the use of Class II rubber bands, but also to the end of eruption, since, at the beginning of treatment, the mandibular molars were more below the occlusal plan in comparison to the Pendulum group because patients were slightly younger and had greater potential for eruption.[13]

The molar relationship at treatment onset showed a statistically significant difference between the Pendulum and control groups, confirming the trend of greater severity of the Pendulum group. As expected, during observation of the change in molar relationship in the course of treatment, the experimental groups presented significative Class II correction when compared to the control group in which malocclusion remained. Therefore, it appears that the treatment successfully decreased anteroposterior interarch discrepancy, which reveals the contribution of this therapy in the correction of the Class II molar relationship and accentuated overjet.

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The literature[3,7,8] proves that intraoral distalization appliances followed by fixed corrective orthodontics are effective in the correction of Class II and that there is stability of about 82% of the occlusal results achieved in the long-term.[1]

Overjet and overbite were similar in the three groups at treatment onset; however, there was a correction in the treated groups during treatment, which was not observed in the control group. This difference was expected since patients in the experimental groups were subjected to corrective treatment and individuals in the control group, in which malocclusion remained at the end of the observation period, the overjet and overbite also remained, i.e., the Class II malocclusion does not correct itself.

Despite the distinct insertion sites among the appliances assessed, i.e., palatal and buccal, no changes were related to this difference, since orthodontic treatment with fixed appliance acts with the purpose of neutralizing the specific effects of intraoral distalization and finalizing the corrective treatment.

CONCLUSIONS

Intraoral distalization appliances followed by fixed corrective orthodontics do not interfere in the cephalometric pattern and tegumental profile, as demonstrated by the results which are similar to the control group with regard to the components of both the maxilla and the mandible, maxillomandibular relationship, craniofacial and tegumental pattern. The mandibular incisors showed significant protrusion and buccal tipping in the experimental groups and the maxillary second molars showed more mesial angulation in the Jones jig group. Finally, correction of Class II malocclusion, overjet and overbite were observed in the Pendulum and Jones jig groups, and in the control group, the initial malocclusion remained at the end of the observation period.

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Brazilian orthodontists and the legal issues involving their professional activity: A legal and behavioral proposal

Elionai Dias Soares[1], Ney Soares de Araújo[2]

Objective: The aim of this study was to review the use of orthodontic records (OTR's) by Brazilian orthodontists and propose a behavioral approach from a legal point of view, drawing on their interpersonal relationship with their patients.

Methods: A statistical cross-analysis was performed to compare five groups. A sixth group was created comprising the intersection of the responses provided by the five aforementioned groups.

Results: The results demonstrate that 42.2% of orthodontists require initial and final records and keep orthodontic records throughout their professional career; 13.9% duplicate the initial records and consider patients as the lawful owners of these documents; 19.5% make use of a medical history questionnaire, to be duly signed by all patients; 5.4% acknowledge that the decision to undergo treatment is ultimately the patient's, and, therefore, an alternative response "not perform the treatment" should be included in the questionnaire; 24% recognize the importance of the Consumer Protection Code (CPC), regard the provision of orthodontic services as an obligation of means; and explain to the patient the risks involved in orthodontic practice. Among the 1,469 orthodontists researched, 0% simultaneously took into account all aspects of this study.

Conclusion: It was concluded that Brazilian orthodontists adopt a mistaken legal, professional and behavioral attitude, neglecting to build patient's orthodontic record with due care and in accordance with the law, which makes them vulnerable to patient disputes, contentious or otherwise.

Keywords: Brazil. Agreements. Informed consent. Documents. Legal responsibility.

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INTRODUCTION

Performing an orthodontic treatment with the aid of adequate diagnosis and planning can be time consuming. Moreover, as months go by, the interpersonal contact between patient and professional tends to develop and deepen. With the advent of the Brazilian Consumer Protection Code (CPC), interpersonal relations between clients and service providers have deepened. In their role as service providers, orthodontists have become the target of their patients, now referred to as clients.[1,2]

Most legal actions against doctors in US Courts were sparked by trivial misunderstandings stemming from an ineffective interaction of these professionals with their patients or their patients' parents. However, the number of patient's complaints relating to dissatisfaction with the outcome of treatments carried out by orthodontists who were eventually prosecuted is not significant (about 3%).[3]

Within this worrying context, properly maintaining OTR's is now regarded as crucially important by wary professionals.[4] The issue surrounding "ideal OTR's" becomes even more obvious when a patient, for any reason, discontinues their orthodontic treatment and requests the records produced during their treatment. In this case, orthodontists are often clueless as to how they should respond. After all, to whom do these documents belong and to what extent are these records important to orthodontists? As a result, OTR's reflect a professional's relationship with his or her patient in the form of information documented in various media formats (paper, casts, tracing paper, electronic media etc.). Such documents should always meet legal, therapeutic and scientific criteria that are consistent with orthodontic practice, and may be more or less elaborate and thorough, depending on how careful and dedicated orthodontists choose to be. Be it as it may, these records must remain accessible at any given time and for as long as necessary, thereby protecting the confidentiality between professional and patient. The manner by which an orthodontist documents the information gleaned from their daily monitoring of the orthodontic treatment delivered to the patient clearly demonstrates the attitude of that professional toward their clients.[5]

To this end, the aim of this study was to analyze the use of OTR's by Brazilian orthodontists, examining their behavioral attitudes under a legal point of view, based on their interpersonal relationship with their patients. The results are ultimately made available to the dentist community in the form of a proposal.[6]

MATERIAL AND METHODS

Pursuant to the Brazilian Health Care Council's resolution CNS 196/96, this research project was submitted to the Institutional Review Board of the SLMandic University under file No. 2010/0285 and met with the necessary approvals.

A survey involving 5,355 Brazilian orthodontists was conducted and a questionnaire consisting of 35 questions was prepared. The Microsoft Access 2000® software was used to analyze all data and to prepare reports based on a cross-analysis of the data of interest, according to the results described below.

The second phase of the survey consisted of a computerized statistical cross-analysis of a database comprising responses from 1,469 orthodontists. Specific results were utilized among the alternative responses to questions Nos. 08, 10, 11, 12, 13, 14, 16, 19, 23, 25, 29, 30, 31 and 33, of the aforementioned questionnaire. Five response groups were created. Each group was represented by a filter composed of three results stemming from previous survey questions (Survey I). Each group was analyzed according to the intersection of these responses. A sixth group was created comprising the intersection of the responses provided by the previous five groups. Group data were compared, analyzed and separated according to the orthodontists' opinions on various topics, namely:

a) Filter I — Orthodontists who have initial/final records taken and the OTR's stored throughout their professional career.
b) Filter II — Orthodontists who duplicate the original records of all patients or those of patients who started but interrupted treatment, and believe that the OTR's belong to the patient.
c) Filter III — Orthodontists who administer to all patients a questionnaire, which is signed by each patient.
d) Filter IV — Orthodontists who consider that any decision regarding therapeutic options is up to the patient; they include the alternative "not to undergo treatment" and claim that signing an agreement is of paramount importance prior to starting treatment.

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e) Filter V — Orthodontists who acknowledge the importance of the Consumer Protection Code (CPC) in their profession, regard the orthodontic services rendered to the patients as a duty of means and explain to them the risks involved in orthodontic practice.
f) Filter VI — Intersection of results of the five previous groups.

RESULTS

A total of 5,355 questionnaires were mailed to orthodontists and 1,469 (27.43%) were returned for analysis. All unanswered questions and invalid responses were voided and excluded from these questionnaires. Thus, all valid responses were identified.

Filters I to V and cross-analysis (Filter VI)

q) Filter I: 42.2% of the orthodontists require initial/final records and store the OTR's throughout their professional career.
b) Filter II: 13.9% of the orthodontists duplicate the original records of all patients and believe that OTR's belong to the patient.
c) Filter III: 19.5% of the orthodontists administer to all patients a questionnaire, which is signed by each patient.
d) Filter IV: 5.4% of the orthodontists consider that any decision regarding treatment options is up to the patient; they include the alternative "not to undergo treatment" and argue that signing an agreement is of paramount importance prior to starting treatment.
e) Filter V: 24.0% of the orthodontists acknowledge the importance of the Consumer Protection Code (CPC) in their profession, regard the orthodontic services rendered to the patients as a duty of means and explain to them the risks involved in orthodontic practice.
f) Filter VI: 0% of the orthodontists — Cross-analysis of all filters.

Table 1 shows the number of positive responses and percentages for each one of the filters (considering the total valid responses in each filter). Figure 1 depicts the percentage results and an error bar reflecting the confidence intervals with 95% confidence for each percentage.

DISCUSSION

Data intersection in this survey showed, quantitatively, the understanding and behavior of Brazilian orthodontists toward various issues involved in an interpersonal relationship with their patients.

Most disagreement between parties has a subjective origin and is often structured outside the legal field. Such disputes are driven by unconscious circumstances, influencing human relations through hidden interests which underpin all litigation. These disputes resurface in the process in the guise of straightforward complaints and irreconcilable demands.[7]

Taking initial/final records and safely storing the OTR's throughout the entire professional career

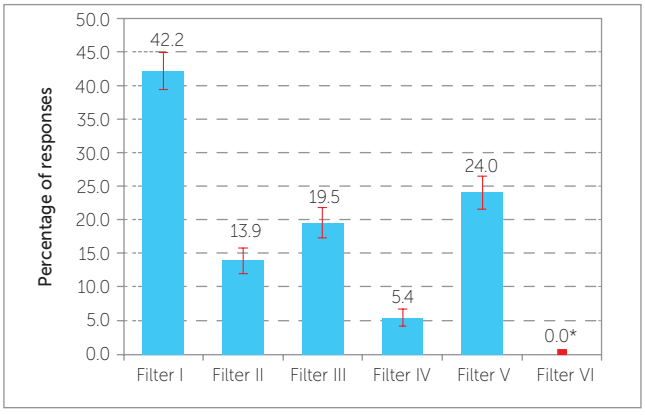
The absolute majority of Brazilian orthodontists require that candidates for orthodontic treatment have initial records taken. Brazilian professionals regard such basic documents as essential to initiate orthodontic treatment.

Table 1 - Distribution of responses according to each filter.

Filter	Responses		Percentage	CI (95%)*
	Positive	Valid		
I	568	1347	42.2	39.5 to 44.9
II	183	1314	13.9	12.1 to 15.9
III	244	1252	19.5	17.3 to 21.8
IV	71	1317	5.4	4.2 to 6.8
V	308	1282	24.0	21.7 ; 26.5
VI	0	890	0.0	0.0

* Interpretation of the confidence interval reveals that the real percentage of the population will be 95% sure within the interval.

Figure 1 - Percent distribution of the responses and 95% confidence interval for the filters.



* The intersection of all filters displayed zero percent, indicating that none of the 890 valid respondents met the five criteria simultaneously.

Of Brazilian orthodontists, 70.56% consider that the final records are essential while 26.13% asserted that they were necessary only in some cases. Nevertheless, some orthodontists pointed out the difficulty encountered in obtaining such records since patients claim they cannot afford it.[5]

However, although the final dental records play an extremely important role in the analysis of the treatment performed, these documents are not usually taken and are simply ignored in orthodontic practice, which makes it very difficult to prove that the proposed treatment was successfully performed. Thus, at the end of treatment, orthodontists should require the patient to obtain the final records and sign a copy of the request form as a receipt.[8,9]

Although professionals registered with the Brazilian Federal Council of Dentistry (CFO) are obligated to prepare the patients' clinical records and keep them on file, much confusion still surrounds this issue, for if, on the one hand, the Civil Code establishes that individual lawsuits are time-barred by the statute of limitations in twenty years, on the other hand, the Consumer Protection Code (CPC) provides that any suit for damages brought against service providers is time-barred in five years, counted from the moment that one is made aware of the losses and the party liable for such losses.[10,11]

However, OTR's must be kept on file for an indefinite period of time. Keeping the records of dental patients on file is usually regarded as a cautionary measure among U.S. orthodontists.[12]

A cross-analysis of the responses provided by Brazilian orthodontists (Filter 1) shows that 42.2% of these professionals comply with the survey recommendations that they should have the patient produce initial and final records and safely store the patient's OTR's for an indefinite period of time, at least throughout their professional career.

Understanding that orthodontic records belong to the patient and duplication of records in cases of treatment interruption and/or all cases

Given that orthodontists are merely trustees of the OTR's, all records must be delivered to their rightful owner, i.e., the patient, upon request. It is up to the orthodontist to document this delivery by means of a voucher or receipt duly signed by the patient or their legal guardian.[4,9] However, a considerable number of patients claim that professionals show reluctance to surrender the OTR's. This statement is grounded in the fact that most professionals (79.01%) mistakenly believe that the OTR's belong to the orthodontist since he/she is responsible for the treatment outcome.[5,13]

Orthodontists are free to make copies of all orthodontic records and return them to the patient upon treatment completion. To this end, professionals should ask patients to sign a receipt with the description of the documents being delivered so that the patient is compelled to act as a trustee. Additionally, patients should be advised that those documents must be carefully stored and presented both in the review consultations and/or in court, if necessary.[9]

It was found that only 13.9% of Brazilian orthodontists studied in this survey (Filter II) agree with the authors in (a) considering that the OTR's belong to the patient and (b) duplicating the treatment records when treatment is interrupted and/or in all cases.

Obtaining the medical history of all patients, duly signed by them

Patients eligible for orthodontic treatment should be invited to fill out a form with information on the patient's medical history. However, professionals must ascertain that all responses be provided.[8]

In Brazil, the Civil Procedure Code (2010) establishes that statements reported in private documents, be they written and signed or only signed, shall be deemed true by the signer. Moreover, although orthodontists are aware of the legal implications, 76.56% of professionals neglect to ask the patient to sign the clinical procedures card.

The first interview should therefore begin with an analysis of the patient's medical history as well as any dental conditions caused by previous treatments. This initial stage should be well conducted and signed by the patient, a technical standard that should be adopted in any clinical situation. Negligence in carrying out an effective medical history interview constitutes professional malpractice, which may render the professional liable to ethical and legal action.[8,15,16]

Therefore, the written record of the initial interview should be based on an objective questionnaire, which should be dated and signed either manually or digitally by the patient or their legal guardian.

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A well formulated OTR, given the current relevance of Dentistry to the public eye, would result in a better relationship with the patient, a better image for the dentist as a health care provider, thereby reducing the likelihood of issues arising from the services provided to the patient, in the event of any legal action.[9,17,18]

It was found that only 19.5% of Brazilian orthodontists (Filter III) are in agreement with the authors of this study, as they conduct a medical history interview by means of an objective questionnaire administered to all patients and require them to provide their signature.

Selling an agreement, understanding that the decision to undergo treatment is in the patient's hands and inclusion of an alternative "not to undergo treatment" as one of the treatment options

Selling a written agreement is crucial and the ideal moment to sign it is approximately one week before placement of the orthodontic appliance. Consent and surgical procedure should be discussed on separate occasions and the patient should take the questionnaire home, which would allow them time to ponder the proposed procedures.[12,17] As a result, patients will be respected for their own principles of autonomy and their own desire, as they are given a chance to either accept or reject the orthodontist's proposed treatment.[19,20]

Moreover, the Brazilian Penal Code stipulates a punishment of three months to one year imprisonment, or payment of a fine, for any person who embarrasses another, either through violence or serious threat, or compromises, by any other means, another person's ability to not do what the law allows, or do what it does not require. The same code provides that surgical or medical interventions can be performed without the consent of the patient or their legal representative when there is imminent threat to the patient's life.[21]

Therefore, the State Council of Dentistry (CEO) has established that it is an ethical violation to start any dental procedure or treatment without the prior consent of the patient or his legal guardian, except in cases of emergency or urgency, whereas it is likewise an ethical violation to fail to render the services provided for in the agreement.[10]

The orthodontist should submit to the patient and record in the OTR the treatment plan comprising the treatment options to be employed. The decision to undergo treatment is a privilege of the patient and their legal guardians, who are considered stakeholders in the process of rendering orthodontic services. It is also up to them to choose from among the treatment options presented by the professional in a clear, accessible language.[10,20,22]

Therefore, it was found that only 5.14% of the Brazilian orthodontists (Filter IV) are in agreement with the authors of this study, since such professionals (a) sign a service agreement, (b) understand that the choice of orthodontic treatment belongs to the patient and (c) include the alternative "not to undergo treatment" among the possible treatment options.

The importance of the Consumer Protection Code (CPC) in Orthodontics, duty of means regarding the orthodontic services rendered to the patients and clarification on the risks involved in orthodontic practice

As of the inception of the Consumer Protection Code (CPC), consumers of dental services began to assert their rights in court, and since then there has been an increase in legal actions in the dentistry arena.[1] Similarly, dentists can be penalized if the information provided is insufficient to foster service provision and the attendant risks.[23]

As a result, the expressions clarified consent, voluntary consent, informed consent, post-informed consent and free and informed consent are the various designations of a document that reflects much more than the mere manifestation of the patient after having received all information about the risks, benefits and costs of the treatment they will receive or the research in which they will participate. These documents ensure that patients are respected in their own principles of autonomy and desire, and are, thus, free to accept or reject whatever is being proposed to them.[19,20]

On the other hand, in terms of the amount and type of information that patients really require, a complete term of informed consent submitted in writing generally provides more information than most patients care to receive.[24]

In reviewing the binding nature of the services provided by Brazilian orthodontists, it is necessary to distinguish between duty of means and duty of result. Duty of means requires only that the service providers implement and make use of certain means, irrespective of results. Duty of result, on the other hand,

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implies that if a professional fails to achieve the proposed goal or goals, they fail to fulfill their obligation altogether. When highlighting the risks involved in orthodontic therapy, professionals characterize their activity as duty of means.[25,26]

Orthodontics should therefore be considered a specialty of which nature is that of a duty of means, given that professionals have an obligation to use all means possible to meet the patient's expectations without, however, having an obligation to achieve the results envisioned. Nevertheless, orthodontists should be held accountable when incurring recklessness, negligence, incompetence misleading or deceptive advertising.[2,27,28]

Therefore, understanding the binding nature of a duty of means or duty of result will entail the burden of proof. In the case of a lawsuit involving a duty of result, the burden of proof lies with the professional, who must prove that they applied with utmost expertise the state-of-the-art technique available at the time. On the other hand, in a duty of means, it is up to the patient to prove that the professional did not perform properly nor used state-of-the-art techniques.[29]

It was found that only 24.0% of Brazilian orthodontists (Filter V) are in agreement with the authors of this study in (a) considering the importance of the Consumer Protection Code (CPC) in their orthodontic practice, (b) regarding their professional activity as a duty of means and (c) enlightening their patients on the risks involved in orthodontic practice.

Cross-analysis of all filters

The intersection of all filters displayed a zero percentage, in which none of the 890 valid respondents (who responded to all data cross-analysis items) met the five criteria simultaneously, as required by the authors:

a) Filter I: Orthodontists who request the initial/final records and keep the OTR's on file throughout their professional career.[8,9,11,12,30]
b) Filter II: Orthodontists who duplicate the original records of all patients, and believe that the OTR's belong to the patient.[4,5,9,10,12,13]
c) Filter III: Orthodontists who require all patients to fill out and sign a medical history questionnaire.[8,9,14-16,18,31]
d) Filter IV: Orthodontists who consider that any decision regarding treatment options is up to the patient; they include the alternative "not to undergo treatment" and claim that signing an agreement is of paramount importance prior to starting treatment.[8,10,12,19,20,23,25,32]
e) Filter V: Orthodontists who acknowledge the importance of the Brazilian Consumer Protection Code (CPC) in their profession, regard the orthodontic services rendered to the patients as a duty of means and clarify patients on the risks involved in the practice of orthodontics.[1,2,10,12,17,19,20,24,25,26,28,29,33]

CONCLUSIONS

Based on the field survey conducted in this study, it can be concluded that:

a) Brazilian orthodontists:
- Maintain a mistaken behavioral attitude toward their patients from a legal and/or professional point of view.
- Neglect to cautiously produce the orthodontic records (OTR's) grounded in legal foundations and in light of the concepts that underpin the current stage of orthodontics as a dental specialty.
- Feel vulnerable when questioned by their patients, be it contentiously or otherwise, be it fairly or unfairly, on the legal aspects of their professional practice.

b) The following recommendations are in order:
- Patients should have both initial and final records taken and the OTR's should be safely stored by the dentist throughout their entire professional career.
- Duplication of OTR's, in case these documents are requested by the patients, who are their lawful owners.
- Use of a medical history questionnaire, duly signed by the patient.
- Drafting of a service agreement and understanding that the choice of treatment belongs to the patient, by including an option "to not undergo treatment."
- Orthodontists who acknowledge the importance of the Brazilian Consumer Protection Code (CPC) in their profession, regard the orthodontic services rendered to the patients as a duty of means and clarify patients on the risks involved in the practice of orthodontics.

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Orthodontic movement of teeth with short root anomaly: Should it be avoided, faced or ignored?

Jose Valladares Neto[1], José Rino Neto[2], João Batista de Paiva[3]

Introduction: Short Root Anomaly (SRA) is an uncommon disease and a challenge for orthodontic treatment as it tends to increase the risk of root resorption.

Objective: Assess the current status of the diagnosis, etiology and orthodontic management of teeth with SRA, and present case reports.

Method: A literature review was carried out in PubMed, SciELO, LILACS, Scopus and Web of Science databases.

Results: A differential diagnosis of SRA should be conducted for teeth with incomplete root formation, external apical root resorption, dentin dysplasia type I and post dental trauma root hypoplasia. SRA is genetically determined and orthodontic movement requires changes in clinical and radiographic management in order to restrict damage.

Conclusion: Orthodontic movement of teeth with SRA is contraindicated in extreme cases, only. Caution at all stages could minimize attachment loss and lead to long-term stability.

Keywords: Tooth root. Tooth abnormalities. Root resorption. Orthodontics.

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

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INTRODUCTION

The term short root anomaly (SRA),[12,19] also known as root dwarfism,[27] was introduced and first described by Lind,[19] in 1972, to categorize a rare developmental anomaly characterized by full root formation, but with genetically determined foreshortening. The affected root is smaller or presents the same size of the dental crown, has a tendency towards bilateral involvement and presents no other etiological factors.[2,3,12]

Epidemiologically, the prevalence of SRA ranges from 0.6 to 2.4%,[2,15] but may reach 10% among the Japanese.[5] The incidence is higher in females with a ratio that ranges from 1:2.6 to 1:2.7.[3,15] The most affected teeth are the maxillary central incisors and second premolars, while other teeth may also be affected.[2,19] Some reports present extreme cases in which all teeth are affected, in which case it is described as generalized or multiple SRA.[12,24,27] The condition may also be associated with systemic changes or syndromes[31] and the absence of reports of SRA in primary dentition presupposes that it occurs exclusively in permanent dentition.[3]

The literature has given little attention to orthodontic movement of teeth with SRA, despite the high risk of root resorption.[17] The fact that the number of cases reported is limited could be partially explained by lack of identification of this anomaly which is misdiagnosed as root resorption.[10] For this reason, concerns about the diagnosis, etiology and orthodontic movement of teeth with SRA led to the objectives of this study.

MATERIAL AND METHODS

The present literature review was undertaken in the form of searches in PubMed, SciELO, LILACS, Scopus and Web of Science databases. Out of a total of 60 articles found, 35 were selected for this review, covering the topics described below.

Short roots: definition and differential diagnosis

Short roots have origin in both physiological and pathological circumstances. When the maxillary central incisors and first molars erupt in the oral cavity, half of the roots are formed while the other teeth erupt with about ¾. The canines are an exception, as they erupt with root almost complete. This transitional stage of root formation ends with the full development of the root when it reaches occlusal contact.[13]

Lind[19] developed a radiographic method for measuring the relative length of the root, defined as the ratio between the length of the root and the length of the crown (R/C) (Fig 1). In a sample of 1,038 Swedish children, aged eleven or over, the normative value of R/C was 1.63 for males and 1.55 for females, without any statistical difference.[15] The root is considered short when R/C < 1.1:1, in other words, when the root is of the same size or smaller than the crown.[5,15]

There are several diagnostic possibilities for occlusal teeth with short roots. Several reasons explain the undertaking of a differential diagnosis for teeth with short roots, especially due to the frequency of publications reporting wrong diagnosis[10] (Fig 2):

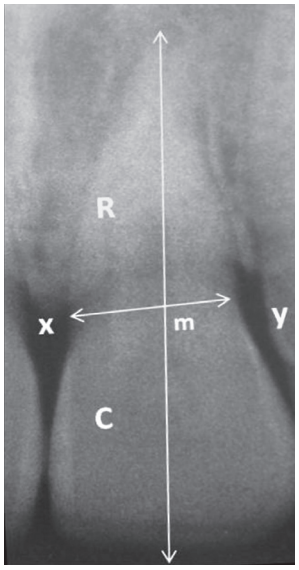


Figure 1 - Measurement of root/crown (R/C) ratio. Points of intersection between the root length, x and y are joined by a straight line. The length of the root (R) is measured by the midpoint below this line (m) at the apex, and the length of the crown (C) from m to the midpoint of the incisal edge (as suggested by Lind[19], 1972).

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- Incomplete root formation: a physiological condition, tooth erupting and incomplete apex.[13]
- SRA: congenitally short root, complete root formation, pointed or rounded apexes. Evident bilateral involvement found only in permanent dentition. It mainly affects the central incisors and second premolars, but it may also be generalized.[2,3,12,19]
- External apical root resorption: decrease in apical root length after full root development. The apical format is typically rounded and irregular. It is triggered by various factors, including: orthodontic treatment, alveolodental trauma, periapical lesions, pericoronal follicle of teeth with deviant eruption, among others.[10]
- Dentin dysplasia type 1: short root due to atypical dentinogenesis. It is associated with pulp obliteration and root surrounded by bone radiolucence in cavity-free teeth. There is a possibility of loss and early exfoliation and the involvement of both deciduous and permanent dentitions.[28]
- Post-trauma root hypoplasia in the deciduous predecessor: short root due to interruption of normal dentinogenesis as a result of alveolodental trauma. Generally unilateral involvement.[30]

Thus, SRA differs from other conditions characterized by short roots. The diagnosis is randomly made through image, since the condition is asymptomatic. Clinical and radiographic findings are normal, except for shorter roots (Fig. 3). The low collagenolytic activity in periodontal tissues is different from cases of periodontal disease or active root resorption.[4] In cases of severe root foreshortening, there may be an increase in tooth mobility, indicating loss of periodontal attachment and secondary occlusal trauma. Undoubtedly, the concomitant presence of SRA and apical dental resorption makes the diagnosis more complex.

ETIOLOGY OF SRA

The etiology of SRA has not been fully determined. Isolated cases of unknown origin have been reported, and have been categorized as idiopathic.[11]

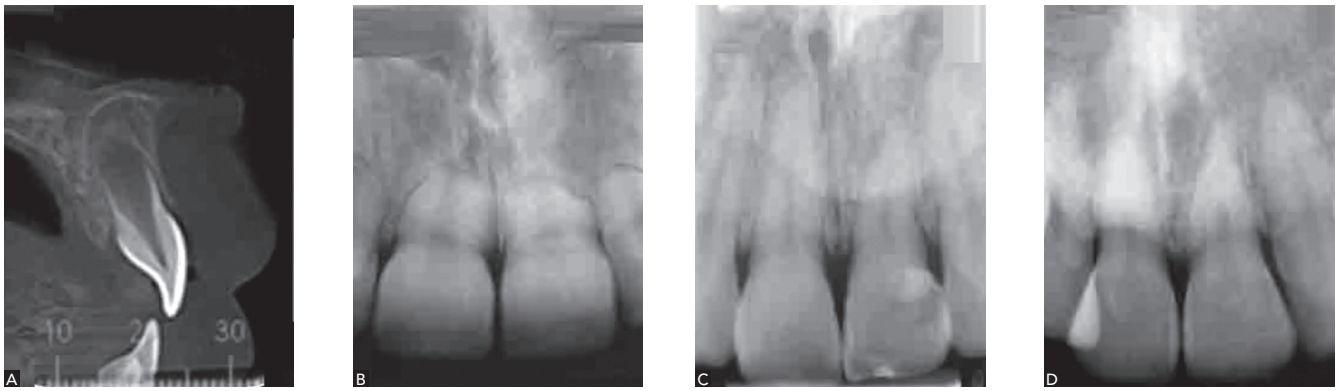


Figure 2 - Short roots due to: **A**) incomplete root formation, **B**) external apical root resorption, **C**) alveolodental trauma, and **D**) short root anomaly.

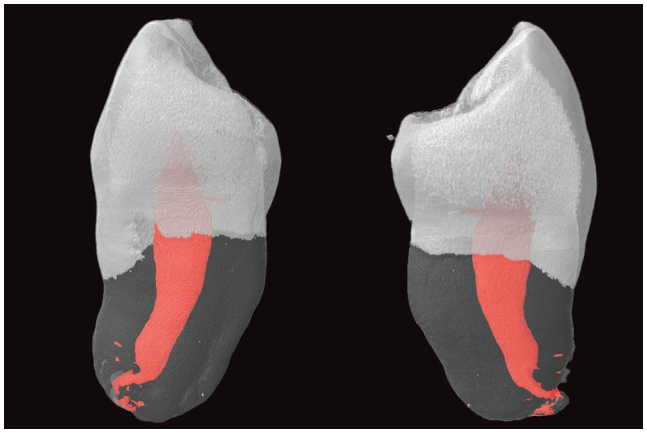


Figure 3 - Three-dimensional computed microtomography of proximal surfaces (distal and mesial) of lower premolar with short root anomaly. In red, the dental pulp, and in white, the enamel (microtomographic X-ray Sky Scan 1076, NRecon and CTan software).

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Others have been described as having a congenital origin, compatible with the term anomaly, because the roots are short as a result of a disturbance during dental development.[2,3,12,19]

In this context, environmental and genetic influences have been suggested. The influence of alveolodental trauma,[30] masticating stress[5] and chemotherapy/radiotherapy[22] have all been reported as inhibitors of root formation. However, evidence suggests that SRA has strong genetic origins, shown by striking family history.[2,12,19] Nevertheless, because of the apparent heterogeneity of the lineage, no definitive conclusions regarding the type of inheritance could be reached, so nonsyndromic SRA could be included in the dominant and recessive autosomal models.[2,12,19] In addition, the genetic theory is reinforced by the intense correlation of SRA with other tooth development anomalies, particularly hypodontia, microdontia (cone-shaped lateral incisor), *dens invaginatus*, taurodontism, pulp obliteration, supernumerary teeth, root dilaceration and ectopic eruption.[2,11,28,35] In spite of that, the occurrence of SRA was not higher in people with palate fissures, among whom there is a high prevalence of dental abnormalities.[1]

A possible biological basis can be understood from the regulatory role of the Nfic gene.[24] Immunohistochemistry and *in situ* hybridization in rats has attributed the formation of short abnormal roots to the absence of the Nfic gene, responsible for the differentiation of odontoblasts.[24] Genetic sustainability is also enhanced by bilateral involvement in the same individual, with a possibility of generalized or multiple involvement.[12,27] There have been reports associating SRA with systemic changes or syndromes, as in certain types of growth deficiency,[26,35] scleroderma,[14] hypoparathyroidism,[16] tumoral calcinosis,[8] congenital dyskeratosis[34] and in syndromes, such as Down,[25] Stevens-Johnson,[31] Turner,[21] Klinefelter,[33] and Laurence-Moon-Bardet-Biedl[17] (Fig. 4).

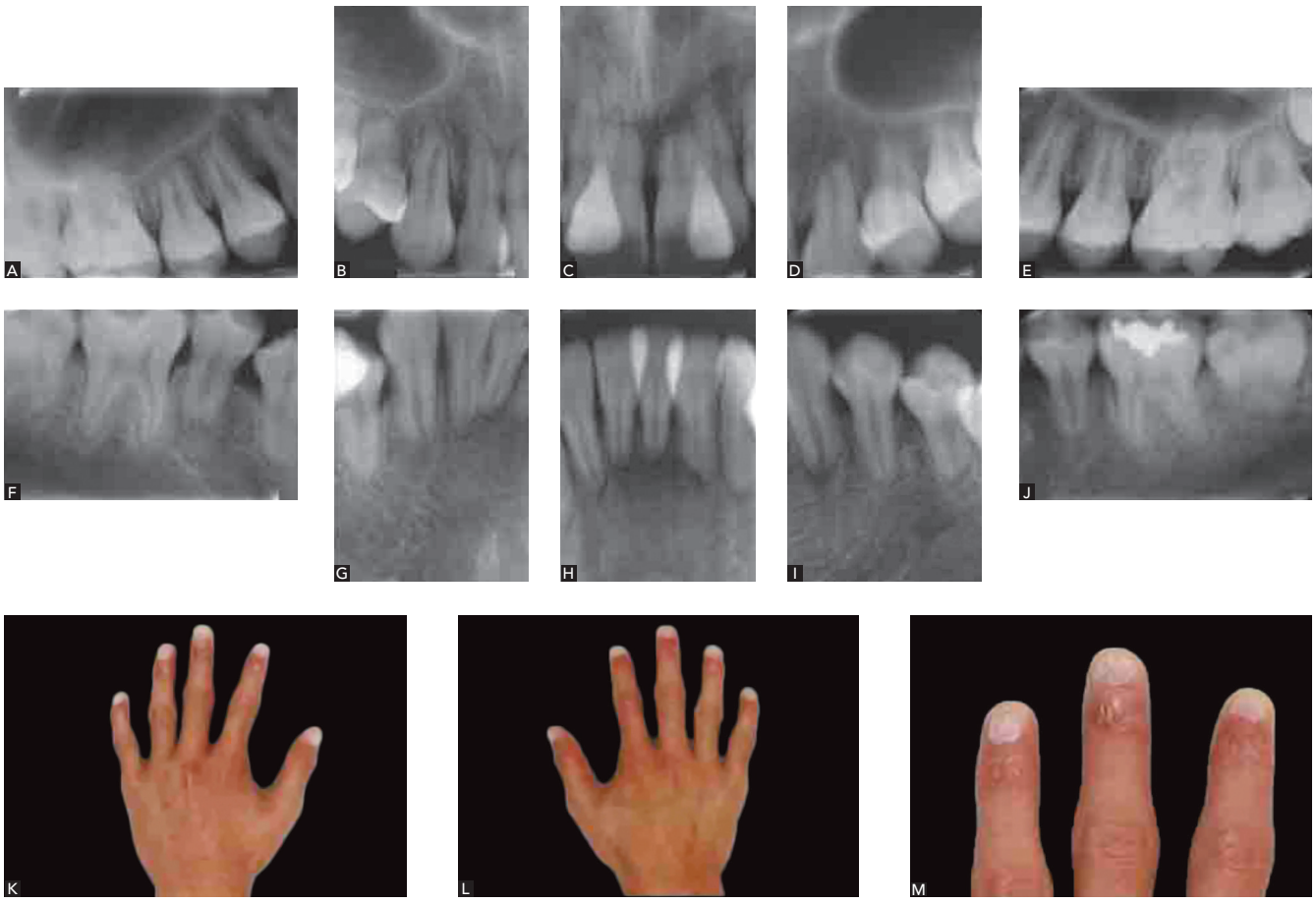


Figure 4 - Generalized short root anomaly in patient with congenital dyskeratosis syndrome (a predominantly recessive X-linked syndrome, characterized by the triad of skin hyperpigmentation, membrane leukoplakia and nail dystrophy). **A-J**) Periapical radiographs; **K-M**) Photographs of right and left hands showing nail involvement.

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Implications of orthodontic movement in teeth with SRA

Orthodontic movement in teeth with short roots tends to generate a higher risk of root resorption, probably influenced by a lower R/C ratio.[17] A test carried out with the finite element method showed that short roots concentrate greater mechanical stress in the middle of the root,[23] which would supposedly be harmful to the cementoblast layer because of extensive hyalinization coming from the periodontal ligament.[10]

At first, orthodontic movement is only contraindicated for teeth with SRA in extreme cases.[12] In most cases, clinical and radiographic monitoring can be used to control dental resorption.[20,27,29] The procedure should initially start with a careful clinical examination to assess the degree of tooth mobility, because if it is excessive, it will restrict the onset or continuity of orthodontic movement. Orthodontic treatment planning should allow an objective and coherent correction of the malocclusion.[27,29] Light intermittent forces with longer intervals between activation are recommended for the control of dental resorption.[18] Root resorption repair seems to depend on time, with longer intervals between activations producing more extensive repair.[9] In addition, light forces generate an adequate momentum/force ratio (M/F) resulting from the cervical dislocation of the center of resistance. Periodic periapical radiographs should be taken to monitor orthodontic movement in teeth with critical root length (Figs 5 and 6).

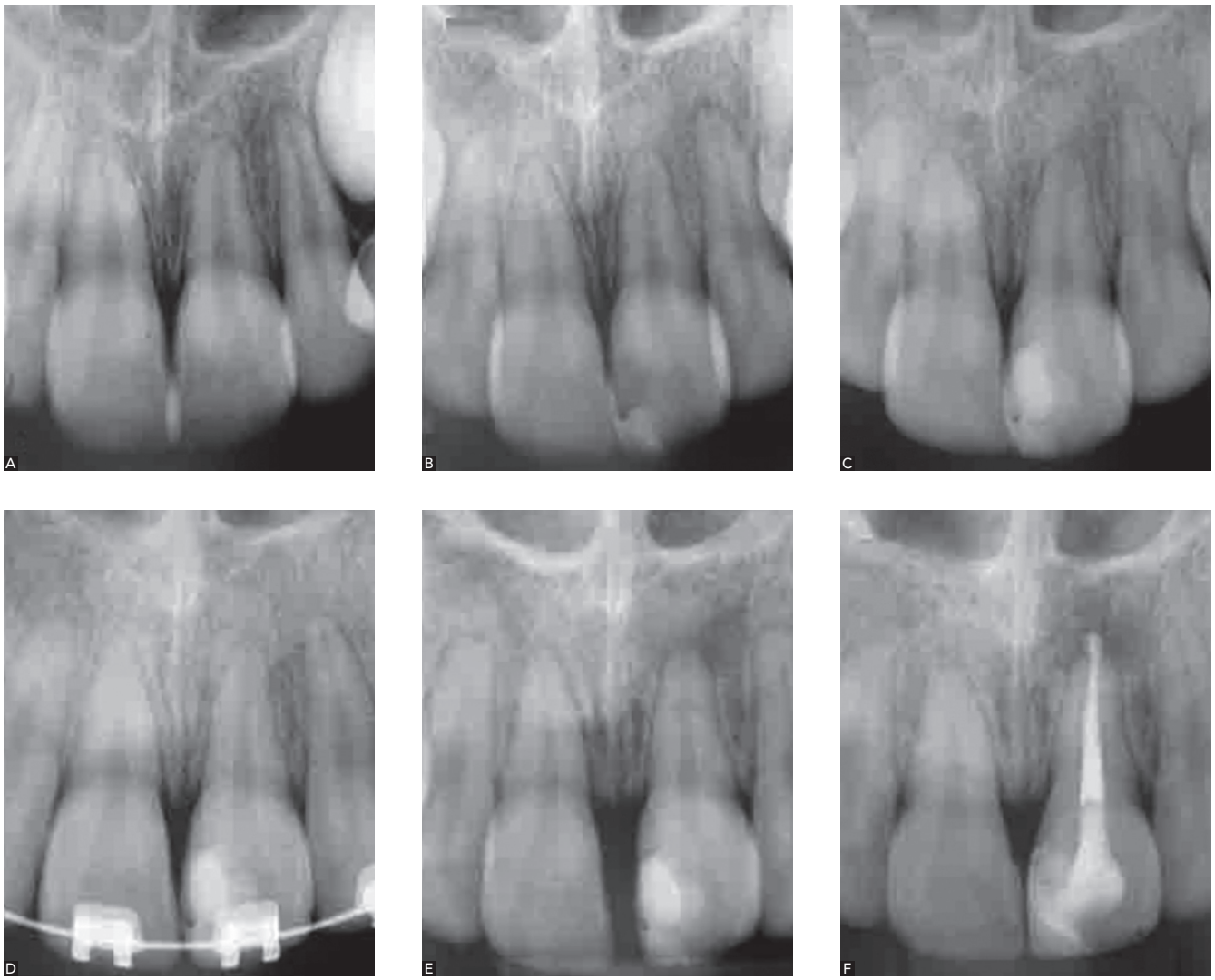


Figure 5 - Radiographic sequence of maxillary central incisors with short root anomaly (SRA). **A**) Mixed dentition indicating early stages of SRA; **B**) before, **C**) during and **D, E, F**) after orthodontic movement, showing relative control of external apical root resorption .

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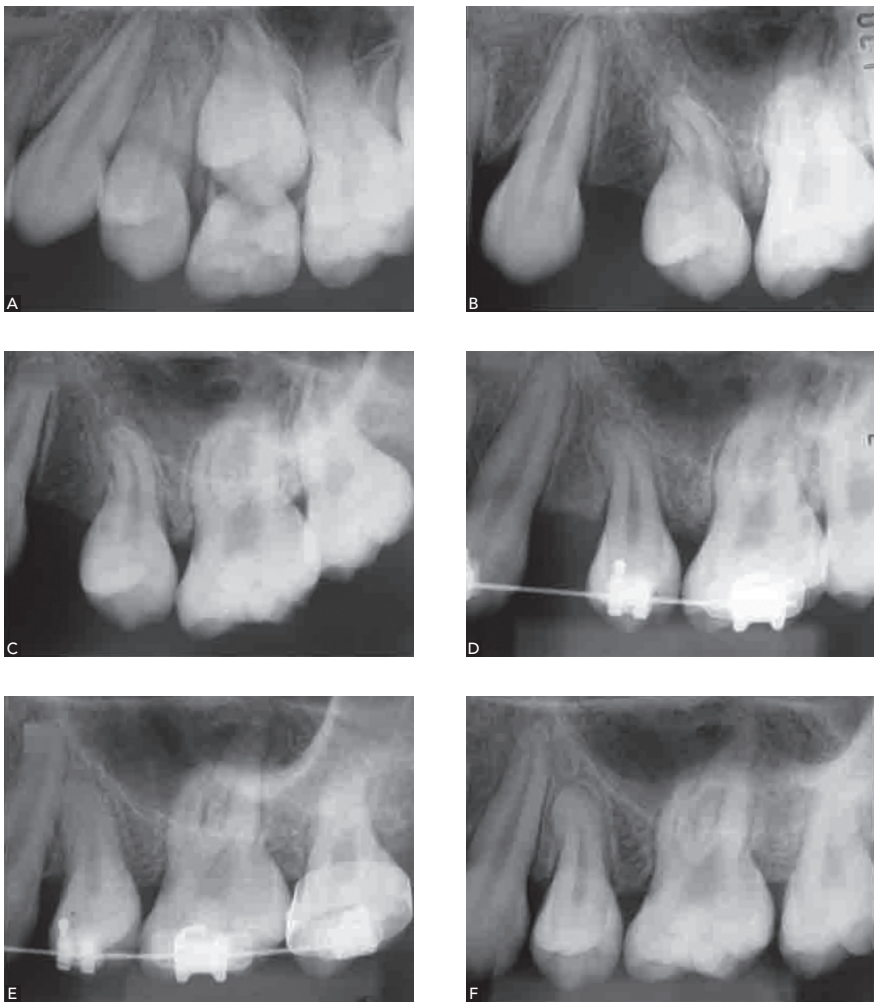


Figure 6 - Radiographic sequence of upper second premolars with short root anomaly (SRA). **A**) Mixed dentition indicating the early stages of SRA; **B**) before, **C**) during and **D,E,F**) after orthodontic movement, showing relative control of external apical root resorption.

Orthodontic movement of teeth with little insertion seems to be faster not because of more intense bone remodeling , but because of excessive inclination . Despite poor evidence, post-treatment relapse seems to be immediate. Case reports involving orthodontic movement in teeth with decreased insertion, as in cases of advanced periodontal disease[6] or after an apicectomy,[32] have recommended the use of a permanent fixed splint. The same procedure should be recommended in cases of movement in incisors with SRA, in order to contain excessive tooth mobility and ensure long-term stability.[20]

CASE REPORT

A brown-skinned female, aged 12 years and 11 months, complaining about dental esthetics, sought the clinic of Orthodontics specialization course in the Foundation for Scientific and Technological Development in Dentistry, at the College of Dentistry, University of São Paulo (USP) requesting orthodontic evaluation. The patient and her parents were most concerned about the presence of infralabial inclined canines. The anamnesis showed good general health, no history of dental or facial trauma and no previous orthodontic treatment. At the time, family dental history was not an object of investigation.

The facial examination showed a brachyfacial pattern without any obvious skeletal asymmetry, convex facial profile, small nasal projection, and an acceptable nasolabial angle. The smile analysis showed adequate exposure of the upper incisors, taking her age into consideration, but indicated a slight dental midline deviation to the right and crowding of the upper canines in a marked infralabial inclined position of the right canine (#13) (Fig 7). The intraoral evaluation showed good dental health and healthy periodontal tissues.

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As for the dental pattern, it presented Class I relationship of right molars. The dental examination presented left subdivision Class II (1/2) malocclusion. The upper right canine erupted in an infralabial inclined position, while the upper left canine was partially erupted due to space deficiency. Overjet and overbite were moderate and both the upper and lower dental midlines were deviated to the right side (Figs 8 and 9). In addition to these aspects, the upper arch was triangular-shaped due to the absence of canines in the dental arch. The shape of the lower jaw was adequate, but with a slight asymmetry in the position of canines and molars, probably attributed to their displacement as a result of the clinical absence of the right second lower premolar (#45). The second deciduous left lower molar (#75) was still in place (Fig. 10).

The cephalometric analysis showed a mild Class II skeletal pattern (ANB = 4.5°), with the maxilla well positioned in relation to the cranial base (SNA = 83°) and slight retrusion of the mandible in relation to the cranial base (SNB = 78.5°), with balanced facial growth (SN-GoGn = 32°), slightly protruded and labially inclined upper incisors (1-NA = 6.5 mm and 1.NA = 25°) and obvious compensation of the lower incisors (1-NB = 7.0 mm and 1.NB = 33°). The examination of the extraoral radiographs confirmed the absence of significant skeletal asymmetry and the agenesis of the second lower left and right premolars (#35 and 45), as well as the lower right third molar (#48) (Fig 11). The examination of the periapical radiographs showed the presence of short root anomaly for the central incisors (#11, 21, 31 and 41) and upper premolars (#15, 14, 24 and 25), and apical root dilaceration for the upper right incisors (#12) (Fig 12).

Considering that the problem of crowded canines was one of the main reasons why the patient sought orthodontic treatment, straightening and leveling of teeth



Figure 7 - Initial extraoral photographs.



Figure 8 - Initial intraoral photographs.

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Figure 9 - Intraoral photograph of the infralabial inclination of the upper canine.



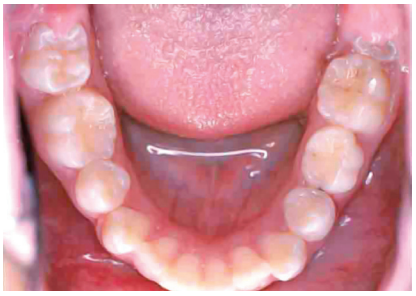


Figure 10 - Initial intraoral occlusal photographs.





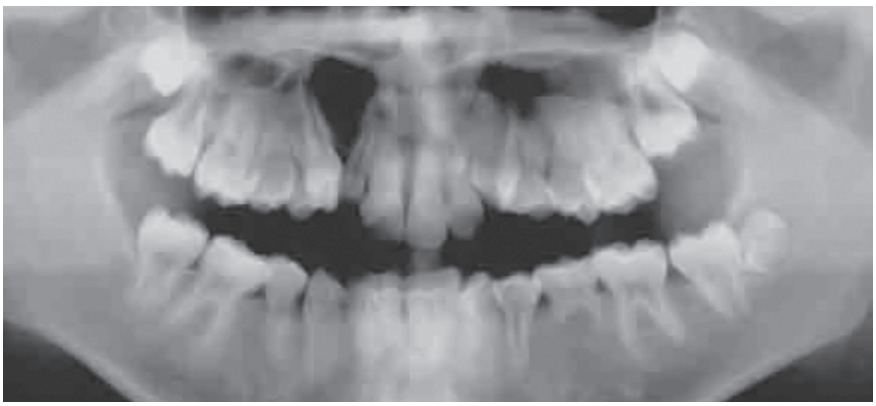


Figure 11 - Initial radiographs.

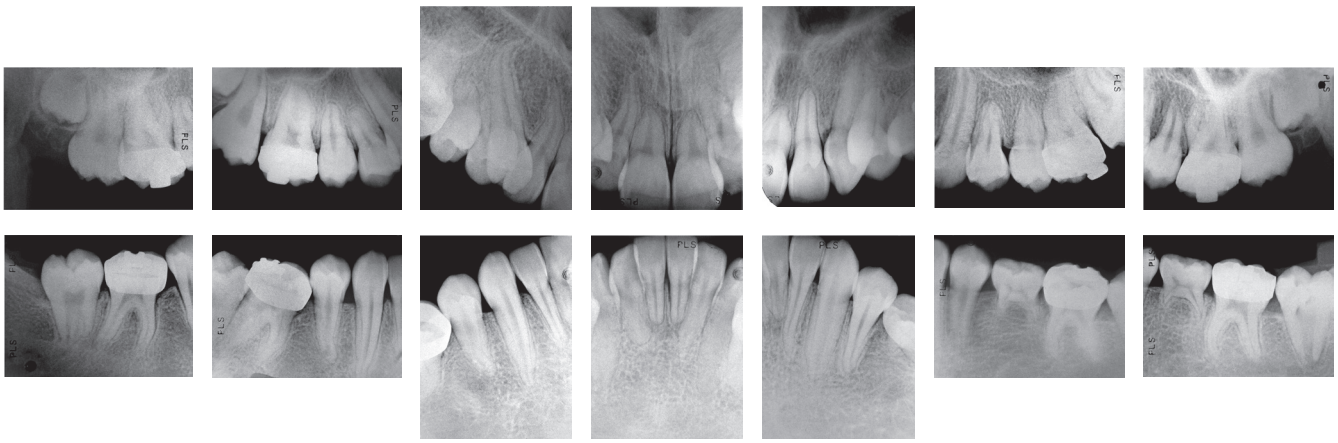


Figure 12 - Initial periapical radiographs.



Figure 13 - Intermediate intraoral photographs.

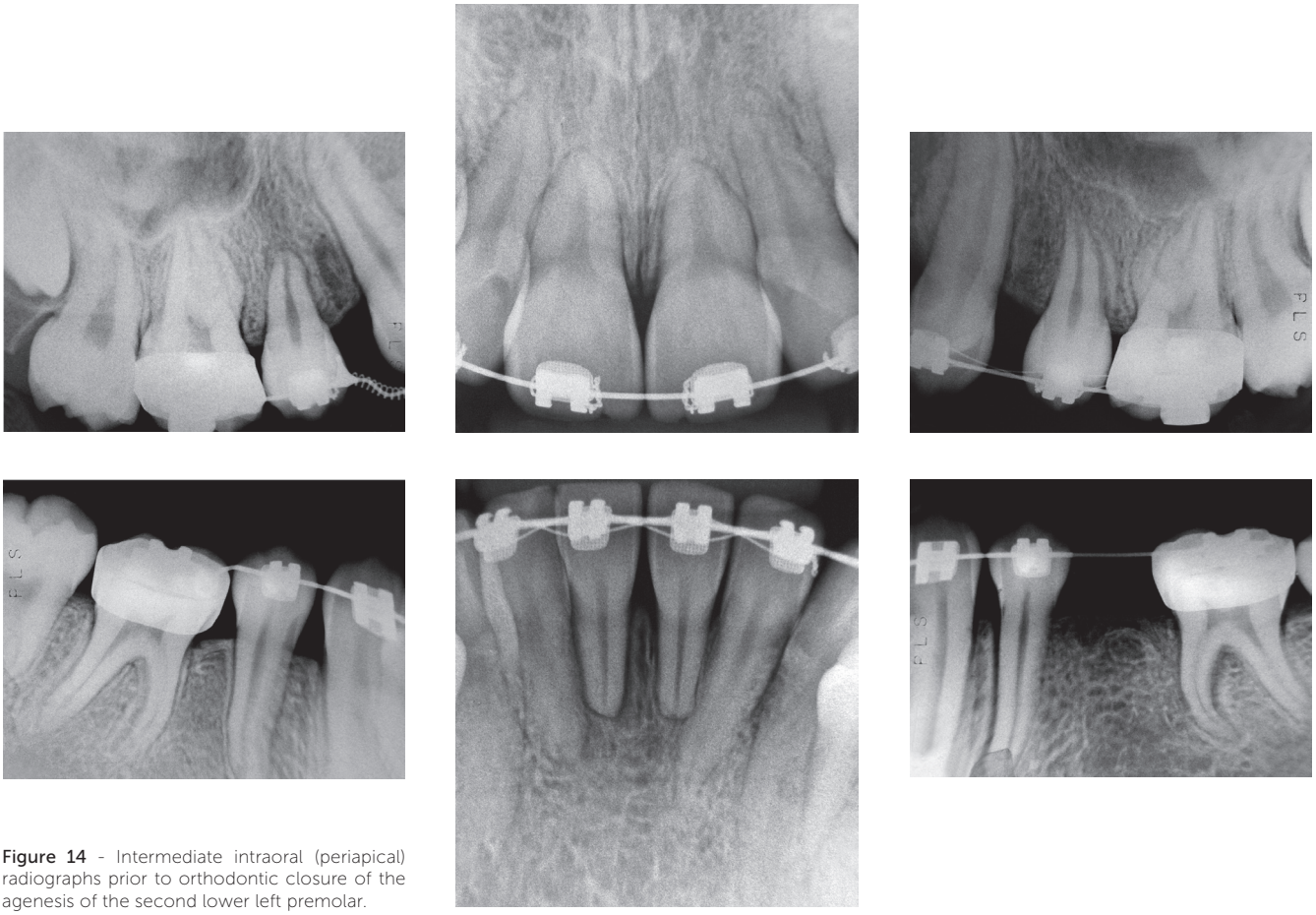


Figure 14 - Intermediate intraoral (periapical) radiographs prior to orthodontic closure of the agenesis of the second lower left premolar.

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and correction of the dental midlines were the aims of the treatment. Molar and canine normal relation were achieved , and overbite and overjet were reduced. In addition, it was decided to close the space corresponding to the missing left lower premolar.

Treatment plan and progress were performed with fixed orthodontic appliances on the upper and lower arches, preceded by the extraction of the first upper premolars (#14 and 24), and the installation of Klöehn headgear (350 g/14 hours). Correction of midline deviations was aided by open coil springs, anterior retraction and inferior reciprocal mechanics to close the agenesis space of the left second lower premolar (#35) (Figs 13 and 14).

Extraction space was then closed and orthodontic detailing performed with the inclusion of second molars and individual bends and torques in the 0.019 x 0.025-in stainless steel arch (Fig 15). Radiographic monitoring was carried out in resorption critical areas, especially after agenesis space closure (Figs 16 and 17). Retention was planned by means of a wraparound removable plate and a fixed intercanine bar with 0.028-in orthodontic wire for the lower teeth.

The esthetic and functional goals proposed at the onset of treatment were achieved, due to the meticulous use of orthodontic mechanics, radiographic monitoring at various stages of the treatment and longer intervals between clinical sessions. As final outcomes, good occlusal relationship between the arches, Class I relationship between molars and canines, and normal levels of overbite and overjet were achieved (Fig 18).

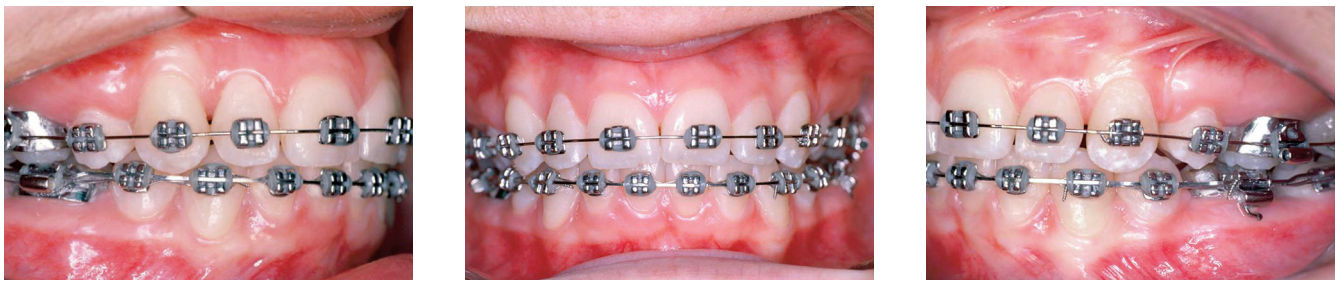


Figure 15 - Intermediate intraoral photographs of finishing phase.

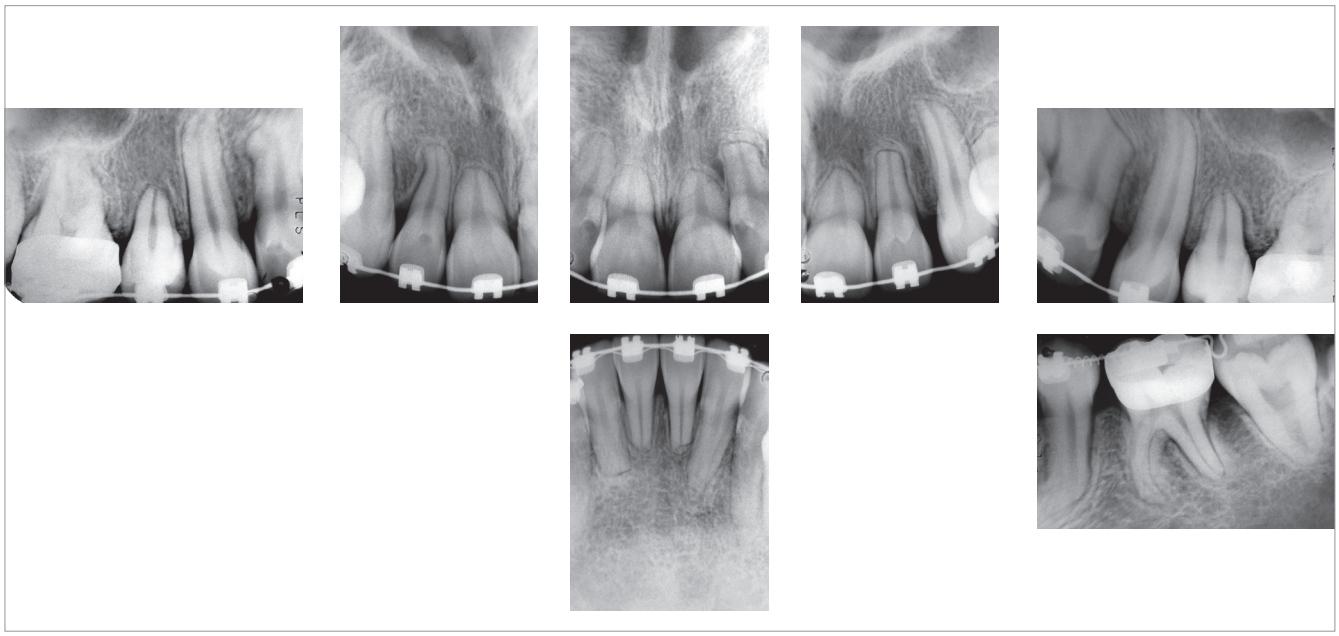


Figure 16 - Intermediate intraoral (periapical) radiographs after closure of agenesis of the left lower second premolar.

These results provided occlusal balance and excursive mandibular movements without interference, and periodontal tissues in good conditions. Dental arch morphology and facial balance were also considered satisfactory at the end of the treatment (Figs 19 and 20). The final extraoral radiographs and cephalometric superimposition are shown in Figures 21 and 22.

Despite the irreversible loss of root length, interruption of the forces that cause resorption tends to paralyze the resorption process and preserve dental insertion (Fig 23). Science has shown that conducting the case without the right care and without the necessary monitoring could culminate in more severe root resorption or even tooth loss.

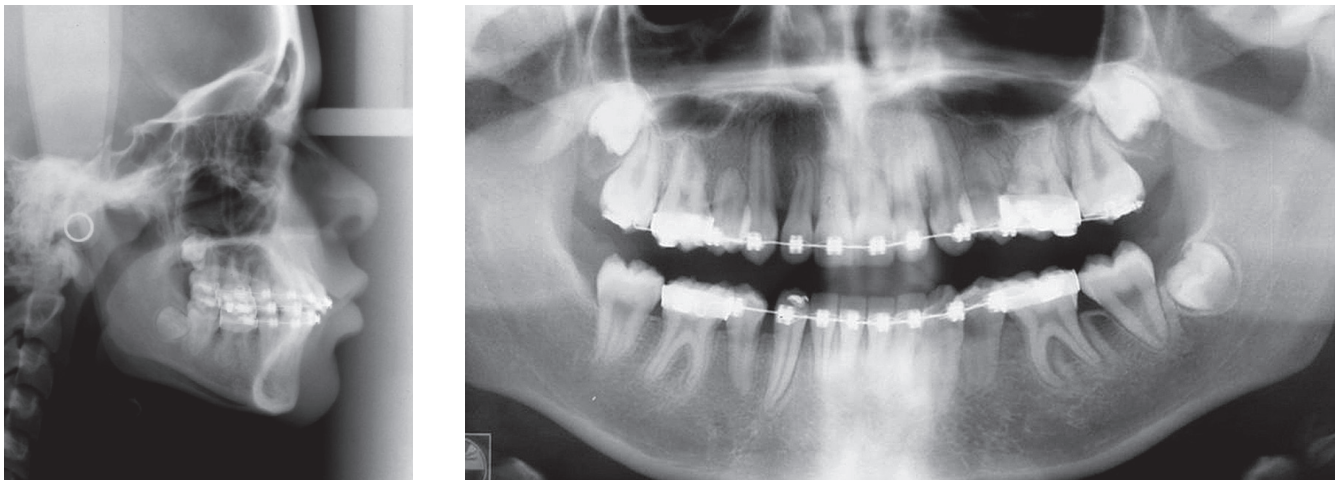


Figure 17 - Intermediate extraoral teleradiograph and panoramic radiographs.



Figure 18 - Final intraoral photographs.



Figure 19 - Final intraoral (occlusal) photographs.

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Figure 20 - Final extraoral photographs.



Figure 21 - Final radiographs: lateral teleradiograph, frontal teleradiograph and panoramic radiograph.

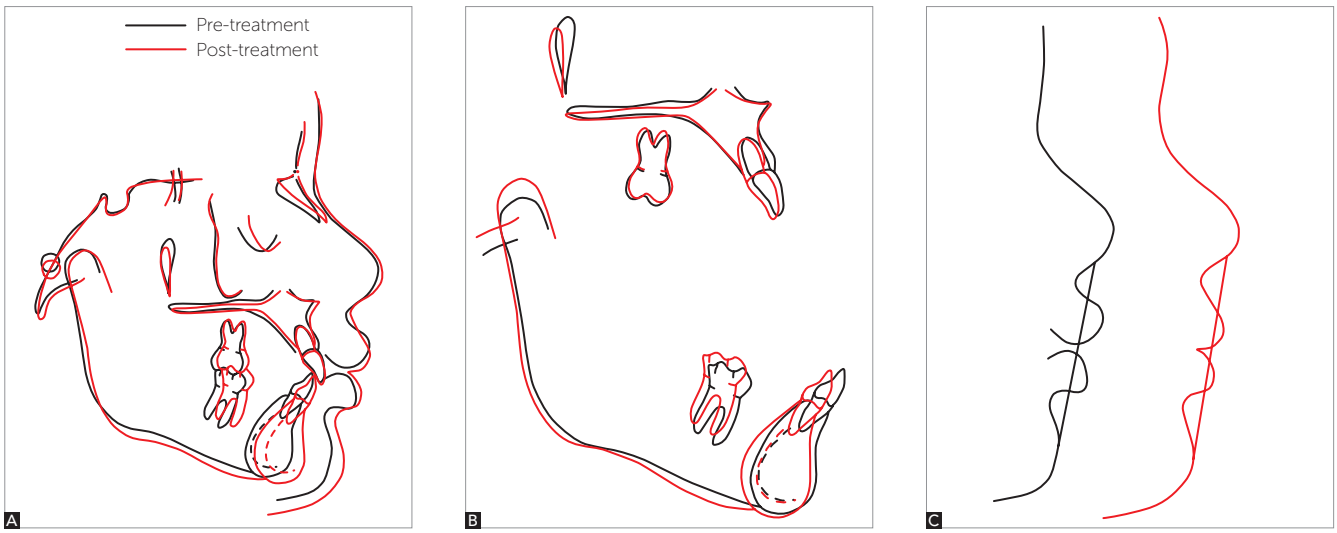


Figure 22 - Cephalometric superimposition before (black) and after (red) orthodontic treatment. **A**) total; **B**) partial; **C**) facial profile and line S.

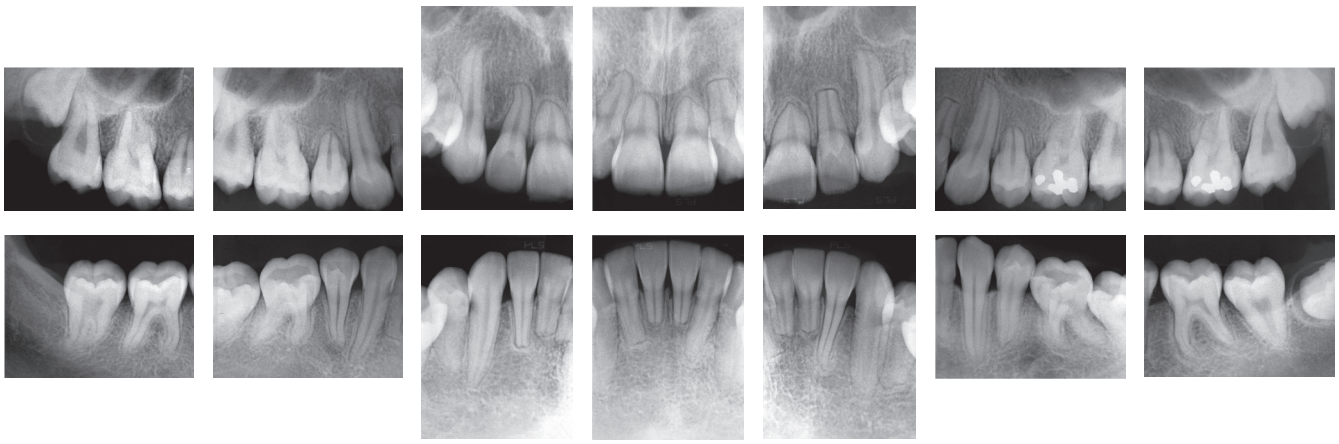


Figure 23 - Final intraoral (periapical) radiographs.

CONCLUSION

Orthodontic movement of teeth with SRA tends to increase the risk of root resorption, however, treatment is contraindicated in extreme cases, only. Differential diagnosis and an understanding of the etiological reasons for teeth with short roots enable orthodontic movement which requires biomechanical adaptations, periodic radiographic monitoring, clinical monitoring of tooth mobility and permanent retention, especially for the incisors.

Acknowledgements

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Procedures adopted by orthodontists for space closure and anchorage control

André da Costa Monini[1], Luiz Gonzaga Gandini Júnior[2], Ary dos Santos-Pinto[2], Luiz Guilherme Martins Maia[1], Willian Caetano Rodrigues[3]

Objective: The aim of this study was to identify the procedures adopted by Brazilian orthodontists in the following situations: extraction space closure, anchorage control in case of necessary anchorage for group A and frequency of skeletal anchorage use, especially in the upper jaw.

Method: A questionnaire was sent to the e-mail address of all dentists registered in the Brazilian Federal Council of Dentistry.

Results: The results showed that most Brazilian orthodontists usually perform extraction space closure by means of sliding mechanics. The use of palatal bar, inclusion of second molars in the archwire and space closure performed in two phases are the most used techniques for anchorage control in the upper jaw. The skeletal anchorage is referenced by 36.5% of specialists as a routine practice for the upper jaw anchorage.

Conclusions: There is a wide variety of procedures adopted by Brazilian orthodontists for orthodontic space closure and anchorage control.

Keywords: Orthodontic anchorage procedures. Orthodontic space closure. Questionnaires.

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INTRODUCTION

Since the introduction of dental extractions as a treatment resource, many space closure and anchorage control procedures have been developed. Space closure mechanics can be classified into two forms: with or without friction. Friction mechanics is that in which the teeth slide on the archwire or the archwire slides on the brackets, whereas in frictionless mechanics the teeth are moved by loop action. Anchorage is classified in accordance with the differential space closure required between anterior and posterior teeth.[2] Group A anchorage is that in which posterior segments must remain in their original position and space is fully closed by anterior retraction. Group B anchorage requires that approximately half of the space be used for retraction. Group C anchorage requires that nearly the entire space be closed by protraction of the posterior teeth.

Studies assessing clinical procedures for space closure and anchorage control are not common,[10] especially in Brazil. Assessing the procedures employed by Brazilian practitioners may be beneficial for clinicians who can compare their own practice with those presented by the researches and re-evaluate them in future studies. Furthermore, it is a way of identifying the most common clinical practices and those that are in disuse, in addition to the professional training received, which can result in changes in personal practice.

Thus, this paper aims at identifying the procedures adopted by Brazilian orthodontists for extraction space closure, anchorage control in case of necessary anchorage for Group A and frequency of skeletal anchorage use in these cases, especially in the upper jaw.

MATERIAL AND METHODS

On October 23rd, 2008, the Brazilian Federal Council of Dentistry (FCD) had 10,121 orthodontists duly registered, 7,572 of which were registered as specialists in Orthodontics and Facial Orthopedics and 2,549 in Orthodontics. There were 5,423 electronic mails registered. A questionnaire (Fig. 1) was sent to these e-mails with objective and discursive questions about their practice regarding anchorage control and space closure. Out of the total number of electronic addresses, 1,464 were not active and 337 were repeated. Thus, 3,650 electronic mails were actually sent.

The questionnaire comprised six questions, two of which were objective while four were discursive. Question 1 asked about the space closure technique most commonly adopted by the practitioner in his office routine. Question 2 asked about the resources used by them for anchorage control in the upper jaw, in cases of maximum control, with no restrictions on the conduct adopted. Questions 3.1 and 3.2 were about professional conduct for space closure and anchorage control in a case

Figure 1 - Questionnaire used in the research.

1. What is the MOST COMMON technique for extraction space closure used in your office?

a ( ) Elastomeric chain from molar to molar
b ( ) Active ligature (elastomeric chain combined with ligature)
c ( ) Bull loop
d ( ) NiTi coil spring
e ( ) Laceback
f ( ) Other. What?_____

2. In extraction cases requiring maximum anchorage in the upper jaw (the lowest mesial molar movement possible) ROUTINELY, which feature (s) is/are used in your office?

a ( ) Palatal bar
b ( ) Nance palatal button
c ( ) Cortical bone anchorage
d ( ) Molar tip-back
e ( ) Including second molar in the archwire
f ( ) Canines retraction followed by incisors retraction
g ( ) Headgear
h ( ) Class II elastic
i ( ) TAD - temporary anchorage device
j ( ) Other resource. What?_____

3. Consider the following case: adult patient with complete bilateral Class II. The proposed treatment included extraction of two upper first premolars and retraction of anterior teeth. The patient WILL NOT USE EXTRAORAL APPLIANCE NEITHER MINI-SCREW. In your office, in this situation:

3.1 - How is extraction space closure performed?

_____

3.2 - How is anchorage control performed?

_____

4. Consider the following case: adult patient with class I. The proposed treatment included extractions of four first premolars with maximum retraction of anterior teeth. The patient WILL NOT USE EXTRAORAL APPLIANCE NEITHER MINI-SCREW. In your office, in this situation:

4.1 - How is extraction space closure performed?

_____

4.2 - How is anchorage control performed?

_____

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requiring greater control in the upper posterior anchorage, in an adult patient with restrictions on the use of headgear (HG) and mini-screws. Questions 4.1 and 4.2 were about professional conduct for space closure and anchorage control in a case requiring greater control of posterior anchorage in both arches, in an adult patient with restrictions on the use of HG and mini-screws.

The data obtained in the questionnaires were computerized by means of a database created by a Microsoft Excel 2007 spreadsheet. The same software was used to survey the frequency of responses. The results were analyzed by descriptive statistics.

RESULTS

A total of 597 (16.38%) e-mails were sent back. Taking into account the total number of members enrolled in the Brazilian Federal Council of Dentistry, the percentage of response was 5.90%.

The responses were tabulated according to the number of answers the professional chose. Thus, score 1 corresponded to one answer; score 2 represented two answers and score 3 corresponded to three alternatives and so on.

The results of Question 1 are shown in Table 1. They demonstrate that 63.81% use sliding mechanics (friction) while 36.18% use mechanical attraction (frictionless) for space closure. 19.26% of the specialists indicated more than one answer to this question.

As for Question 2, when asked about the resources used for anchorage control in the upper jaw, the two most frequent responses were the use of palatal bar (403) and the inclusion of the second molar in the arch (328) (Table 2). Approximately 36.5% of the respondents claimed to routinely use skeletal anchorage devices in cases of maximum anchorage in the upper jaw.

Table 3 shows the results of Questions 3.1 and 4.1 regarding the space closure technique used in hypothetical cases of Class II and I in Group A anchorage.

Tables 4 and 5 show the results regarding the specialist's conduct of anchorage control in case of hypothetical treatment of Class II and I malocclusion, respectively,

Table 1 - Absolute frequency of responses to Question 1.

Responses	Active ligature	Elastomeric chain	Bull loop	NiTi Coil Spring	Laceback	T loop	DKL loop	Ricketts loops	Other resource	n
1	141	75	116	29	28	19	23	21	34	482
2	50	26	29	32	23	7	7	1	3	88
3	11	9	15	14	9	6	3	0	2	23
4	3	2	2	4	4	1	0	0	0	4
Total	205	112	162	79	64	33	33	22	39	

n = number os specialists. The values of the answers correspond to the number of options given by the same professional.

Table 2 - Absolute frequency of responses to Question 2.

Responses	Palatal bar	Nance palatal button	Cortical bone anchorage	Tip-back	Second molar	Two-phase retraction	HG	Intermaxillary elastic	TAD	MPD	Differential moments	Tip-edge brackets	Other	n
1	19	9	7	0	4	5	9	0	38	1	0	0	0	92
2	54	33	5	2	23	17	16	11	18	0	0	0	2	90
3	86	45	6	8	59	60	35	28	30	3	2	2	2	121
4	95	53	8	12	82	76	62	52	44	0	5	3	3	123
5	76	40	11	15	82	72	52	51	43	2	1	0	3	89
6	54	33	13	16	60	57	49	47	30	0	0	1	3	60
7	17	12	5	10	16	16	15	16	13	0	0	0	1	17
8	2	2	1	2	2	2	1	2	2	0	0	0	0	2
No response	0	0	0	0	0	0	0	0	0	0	0	0	0	3
Total	403	227	56	65	328	305	239	207	218	6	8	6	14	

Second molar = second molar must be included in the arch as an anchorage element; two-phase retraction = canine retraction followed by incisors retraction; HG= headgear; TAD= Temporary Skeletal Anchorage Devices; MPD = Mandibular propulsion devices; N= number of specialists.

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in Group A anchorage. The two most frequent responses in both malocclusions are the use of palatal bar and space closure initially performed with canine retraction, followed by incisors retraction.

DISCUSSION

This research was carried out by means of electronic mail, with 16.38% of response rate. International studies using questionnaires report a response rate of about 50% with questionnaires being applied to patients.[15] Some studies carried out in Brazil with questionnaires being applied to professionals presented similar rates in comparison to the present research.[4,6,14] Studies involving a sample of orthodontists presented a response rate of 6%[3] to 7.7%.[10] Our results had the response rate doubled in comparison to the studies aforementioned.

Table 3 - Absolute (n) and relative (%) frequency of responses to questions 3.1 and 4.1.

Malocclusion	Bull loop n (%)	DKLV loop n (%)	Ricketts loops n (%)	Segmented T-Loop n (%)	Continuous T-Loop n (%)	Others loops n (%)	Sliding mechanics n (%)	Sliding to the canine and loop to the incisors n (%)	No response n (%)
Class II	60 (10.05)	27 (4.52)	24 (4.02)	26 (4.36)	17 (2.85)	54 (9.05)	215 (36.01)	79 (13.23)	95 (15.91)
Class I	42 (7.04)	34 (5.70)	19 (3.18)	16 (2.68)	9 (1.51)	45 (7.54)	223 (37.35)	82 (13.74)	127(21.27)

Table 4 - Frequency of responses to Question 3.2.

Class II	Retraction in 1 phase	Two-phase retraction	Palatal Bar	Lip bumper	Nance palatal button	Second molar	Tip-back	Intermaxillary elastic	MPD	Cortical bone anchorage	Lingual arch	Differential moments	Other	n
1 response	14	5	41	0	9	3	1	9	4	0	0	2	0	72
2 responses	14	64	108	0	29	40	3	63	5	2	0	4	1	160
3 responses	9	148	150	0	78	94	9	103	2	7	3	7	6	201
4 responses	1	97	98	0	57	88	12	78	1	4	4	0	4	111
5 responses	1	33	31	1	22	33	9	31	0	5	2	2	0	34
6 responses	0	2	2	0	2	2	1	1	0	2	0	0	0	2
7 responses	0	1	1	0	0	1	1	1	0	0	0	1	1	1
No response	0	0	0	0	0	0	0	0	0	0	0	0	0	16
Total	39	350	431	1	197	261	36	286	12	20	9	16	12	

Retraction in 1 phase = retraction of incisors and canines in one step; retraction in 2 phases = retraction of the canines and posterior retraction of the incisors; second molar = inclusion of second molar in the archwire as an anchor; MPD = Mandibular propulsion device, N = number of specialists.

Table 5 - Frequency of responses to Question 4.2.

Class II	Retraction in 1 phase	Retraction in 2 phases	Palatal Bar	Lip bumper	Nance palatal button	Second molar	Tip-back	Intermaxillary elastic	MPD	Cortical bone anchorage	Lingual arch	Differential moments	Other	n
1 response	11	5	30	0	4	9	2	5	1	1	1	5	2	65
2 responses	21	25	81	6	28	38	9	11	0	3	33	4	4	121
3 responses	9	96	116	13	44	67	13	33	0	14	66	5	12	159
4 responses	4	120	119	14	68	84	14	47	0	11	89	4	20	146
5 responses	0	47	46	6	24	44	17	24	0	6	27	3	7	50
6 responses	0	15	14	2	13	15	5	9	0	4	9	1	5	15
7 responses	0	4	4	2	1	4	2	4	0	1	4	1	1	4
No response	4	0	0	0	0	0	0	0	0	0	0	0	0	37
Total	49	312	410	43	182	261	62	133	1	40	229	23	51	

Retraction in 1 phase = retraction of incisors and canines in one step; retraction in 2 phases = retraction of the canines and posterior retraction of the incisors; second molar = inclusion of second molar in the archwire as an anchor; MPD = Mandibular propulsion device, N = number of specialists.

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The interest and/or knowledge about the subject involved in the research could have influenced the response rates.[4,9] Presenting a short questionnaire was of paramount importance to increase the response rate.[15] Despite the fact that the questionnaire applied in this research comprised six questions, only, the presence of four open questions may have influenced the response rates. The results showed that the majority of specialists (63.81%) prefer the technique based on friction mechanics for orthodontic space closure. Moreover, active ligature and elastomeric chain proved to be the most used resources in this technique (Table 1). Space closure is the most significant change occurring during the transition period from standard edgewise to preadjusted appliance systems.[13] The preadjusted brackets allowed the use of different techniques for sliding mechanics and the results proved this technique to be highly accepted, when applied. The results of this research are lower than the ones yielded by a British study, in which loops were practically not used for space closure and the sliding technique was used at a rate of 98%.[1]

With regard to Question 2, which questioned about the resources used for anchorage control in the upper jaw, the use of palatal bar and inclusion of the second molar in the archwire were the most cited answers (Table 2). Although it has been widely used for anchorage, the palatal bar does not significantly improve molar mesialization control in extraction cases.[5,11,12,16,18] A longitudinal study concerning the techniques used by American orthodontists showed a decrease in the use of palatal bars. In 2008, only 20% of those who answered the questionnaire stated the use of that device.[10] Likewise, a British study showed a percentage of 24.6%.[1] Even though it is not possible to assert that the device has not been widely used due to being ineffective for anchorage control, that is probably the reason. Nearly half of the specialists (40.8%) combine at least 3 or 4 different techniques for anchorage control in the upper jaw, which means they chose 3 or 4 answers to the same question. As for this question, the specialists could choose skeletal and headgear anchorage techniques. More than 35% (36.5%) of the experts claimed to use the skeletal anchorage technique on a daily basis for group A anchorage in the upper jaw. Previous studies revealed that 20.3%[3] to 39.3%[10] of interviewed orthodontists claim that they have never used mini-screws. These researches are used as reference, but cannot be compared to the present study because the latter used the skeletal anchorage technique for anchorage control in space closure while the others[3,10] have considered all clinical cases. One of these researches[9] showed that using skeletal anchorage for anchorage control is the second technique orthodontists recommend the most, while molar mesialization is the first. However, another study demonstrated that molar intrusion followed by Class II malocclusion treatment are the main indications for the use of mini-screws.[10] Additionally, it is worth noting that the skeletal anchorage technique is used by Brazilian orthodontists more than it is used by the British. Only 0.2%[1] have claimed to use that technique. However, we must bear in mind that this British study was conducted 2 years before the current study.

Questions 3.1 and 4.1 questioned about extraction space closure techniques in cases of Class I and II in which anchorage is strictly necessary (Table 3). The percentage regarding the use of the sliding technique was 36% and 37.3% in Class II and I, respectively. These results decrease when compared to the results of the first question (63.81%). Apparently, specialists take special care with the cases that have been presented in comparison to common cases. Unfortunately, a high percentage of specialists did not clearly state the answer for these questions, which may result in biased interpretation. With regard to anchorage control, no studies suggesting that retraction performed by means of frictionless mechanics is superior to friction mechanics have been carried out. It has been widely accepted that the use of loops allows clinicians to calibrate forces and moment ratios employed during retraction. However, although this situation is extremely advantageous since it provides knowledge of the force systems involved in the mechanics used, there is no scientific evidence of it being associated with a better anchorage control. A few studies have compared both mechanics, however, they do not allow anchorage loss between both space closure techniques to be assessed, since patients used headgear or were submitted to skeletal anchorage. In other words, the arch sides were not independent from each other, thus, not allowing assessment on the response of the space closure mechanics technique used.[7,19]

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Conducts concerning the high need of posterior anchorage control in Class I and II malocclusions are the subject of Questions 3.2 and 4.2 (Tables 4 and 5). When the answers to these questions are compared, nearly 40% of the experts are worried about the use of palatal arch as an anchorage device used for Class I cases, and even more specialists try to avoid the use of intermaxillary elastics. The most common answers with regard to both malocclusions were the use of palatal bar and space closure performed by means of canine retraction at early stages, followed by incisor retraction. To date, two studies aimed at assessing the difference in anchorage loss between space closure performed with unique retraction (one phase) and retraction in two phases (canine retraction followed by incisors retraction).[8,17] The results of both studies showed no significant difference between these different treatment approaches. There is no support in the literature that states the use of two retractions aiming at preserving anchorage. It is probable that such technique is recommended for cases in which partial canine retraction creates spaces for alignment of incisors, in cases of crowding.[17]

Our study reflects the challenges inherent to research-based practice. These include not only difficulty in recruiting patients who may not be motivated to participate in research, but also self-selection of orthodontists who are eager to participate, both of which can lead to biased findings.[1,9]

CONCLUSIONS

The present study demonstrated that:

» The sliding technique is more commonly prescribed by specialists for extraction space closure;

» When specialists are free to choose the technique that is going to be used for anchorage control, they usually perform control based on the use palatal bar with incorporation of second molars. Additionally, when the use of headgear and skeletal anchorage is not possible, the palatal bar and the two-phase space closure technique are the conducts mostly prescribed;

» Skeletal anchorage is used by 36.5% of specialists as an ordinary technique for anchorage control in the upper arch. Nearly 40% of specialists use lingual arch for anchorage control in the lower arch in Class I cases when skeletal anchorage is impossible.

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Prevalence of mesiodens in orthodontic patients with deciduous and mixed dentition and its association with other dental anomalies

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Objective: To determine the prevalence of mesiodens in deciduous and mixed dentitions and its association with other dental anomalies.

Material and Methods: Panoramic radiographs of 1,995 orthodontic patients were analyzed retrospectively, obtaining a final sample of 30 patients with mesiodens. The following aspects were analyzed: gender ; number of mesiodens; proportion between erupted and non-erupted mesiodens; initial position of the supernumerary tooth; related complications; treatment plan accomplished; and associated dental anomalies. The frequency of dental anomalies in the sample was compared to reference values for the general population using the chi-square test (χ^2), with a significance level set at 5%.

Results: The prevalence of mesiodens was 1.5% more common among males (1.5:1). Most of the mesiodens were non-erupted (75%) and in a vertical position, facing the oral cavity. Extraction of the mesiodens was the most common treatment. The main complications associated with mesiodens were: delayed eruption of permanent incisors (34.28%) and midline diastema (28.57%). From all the dental anomalies analyzed, only the prevalence of maxillary lateral incisor agenesis was higher in comparison to the general population.

Conclusion: There was a low prevalence of mesiodens (1.5%) in deciduous and mixed dentition and the condition was not associated with other dental anomalies, except for the maxillary lateral incisor agenesis.

Keywords: Supernumerary tooth. Child. Prevalence.

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

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INTRODUCTION

The term mesiodens refers to supernumerary teeth located in the pre-maxilla region, precisely between the maxillary central incisors (Figs. 1 and 2). Mesiodens is the most frequent type of supernumerary tooth.[1,2] The prevalence of mesiodens reported in the literature varies from 0.15 to 7.8% (Table 1), with a higher prevalence in males, with a proportion of 2:1.[3-10] Although it has not been precisely established, its etiology seems to be related to genetic factors, given the records of family recurrence.[4,11-13] A dominant autosomal trait has been suggested, with incomplete penetrance in some generations[13] and x chromosome linked inheritance due to the higher prevalence among males.

The mesiodens is often unique[3,4,5,7,14] and anomalous in size and shape,[11] but may vary in morphology from a small rudimentary conical shape[4,7,8,9,14,18] to a complex form with several tubercles. It rarely erupts spontaneously,[8,10,14,17] which only occurs in situations in which the mesiodens faces the oral cavity. Most often, the mesiodens is inverted, with the crown positioned towards the nasal cavity and the root apex facing the oral cavity.[3,8,9] The presence of mesiodens can lead to local irregularities of which the most common are: delayed eruption or impaction of adjacent teeth, displacement or rotation of adjacent teeth, development of dentigerous cysts, resorption of adjacent roots, crowding, midline diastema or maxillary incisors root dilaceration.[1,3,4,5,7-11,14,17]

Studies have suggested a genetic and hereditary background in the etiology of dental anomalies of number, size and position. Such evidence comes from investigations carried out with families, monozygotic twins and the observation of associations in the occurrence of certain anomalies.[11,19,20] Tooth agenesis is often associated with other dental anomalies, such as microdontia, ectopia and delayed dental development.[19,20,21] Peck[20] has recently denominated the association of these occurrences as dental anomaly patterns (DAP), as a single mutant gene may be responsible for more than one morphological or functional trait.

Two previous studies verified the association between supernumerary teeth in general and other dental anomalies, including tooth agenesis, microdontia and ectopic eruption.[19,21] The findings revealed that the frequency of supernumerary teeth was not higher in patients with hypoplastic dental anomalies.[19,21] However, no previous study has investigated the exclusive association of mesiodens with other dental anomalies.

Thus, the aim of the present study was to verify the prevalence of mesiodens in children with deciduous and mixed dentitions and its association with other dental anomalies.



Figure 1 - Mesiodens erupted in the oral cavity.

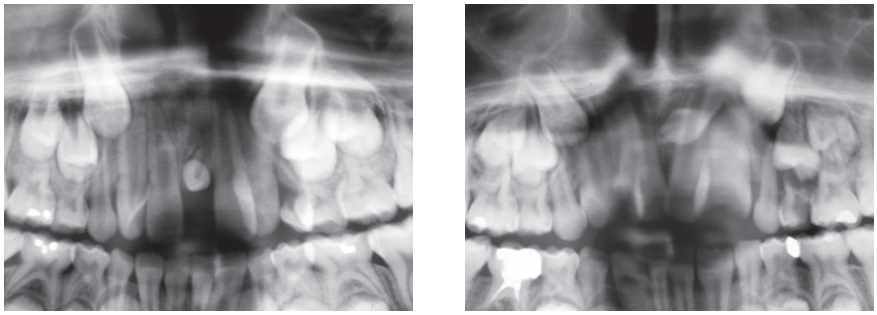


Figure 2 - Radiographic image showing mesiodens.

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MATERIAL AND METHODS

The orthodontic records of 1,995 patients with deciduous and mixed dentition, taken from the archives of the Profis Preventive and Interceptive Orthodontics Course (Bauru, SP, Brazil) were retrospectively analyzed. Panoramic and periapical radiographs were analyzed by a single examiner. The inclusion criteria were: patients aged between 4 and 13 years old; with deciduous or mixed dentition; presence of at least one supernumerary tooth in the midsagittal region of the maxilla. The exclusion criteria were: presence of craniofacial anomalies; presence of syndromes; history of tooth extraction and incomplete documentation. After the initial analysis, a sample of 30 patients with mesiodens and a mean age of 8 years and 3 months was obtained.

The following aspects were analyzed in the orthodontic records of the sample: 1) sex; 2) number of mesiodens; 3) proportion between erupted and non-erupted mesiodens; 4) initial position of the supernumerary tooth; 5) related complications; 6) treatment planning accomplished; and 7) associated dental anomalies. The associated dental anomalies investigated included agenesis of permanent teeth, microdontia, ectopic eruption of permanent maxillary first molars, tooth transpositions, palatally displaced canines (PDC), distoangulation of mandibular second premolar, infraocclusion of deciduous molars, delayed tooth development and supernumerary teeth (in addition to mesiodens).

Diagnosis of palatally displaced maxillary canines followed the radiographic parameters suggested by Lindauer et al[22] confirmed by the interpretation of periapical radiographs by the tube shift method of object localization using two projections with significantly different x-ray tube angulations. Considering the findings of Ericson and Kurol[23] in which the attempt to determine the eruption path of maxillary canines radiographically is generally of little value in children under 10 years old, those subjects whose only diagnostic records were from an age under 10 years were excluded from the sample when evaluating palatally displaced canines. Diagnosis of distoangulation of mandibular second premolars followed the criteria described by Shalish et al[24] using the lower edge

Table 1 - Prevalence of mesiodens reported in previous studies and in our study sample.

Author	Number of subjects analyzed	Age range	Method	Origin of the sample	Prevalence of mesiodens
Montenegro et al[1]	36,057	5 to 56y	Analysis of patient's file	Unidad Ambulatoria de Cirurgía Bucal (Spain)	0.15%
Gündüz et al[14]	23,000	4 to 14y	Radiographic	Ondokuz Mayis University (Turkey)	0.3%
Buenviaje and Rapp[15]	2,439	2 to 20y	Radiographic	University of Pittsburgh (USA)	0.4%
Järvinen and Lehtinen[16]	1,141	3 to 4y	Clinical	University of Kuopio/ Public Health Centre (Finland)	0.4%
Tyrologou et al[9]	11,500	3 to 15y	Clinical and radiographic	Department of Paediatric Dentistry – Institute for Postgraduate Education (Sweden)	0.8%
Hurlen and Humerfelt[17]	63,029	9 m to 80y	Clinical and radiographic	University of Oslo (Norway)	1.4%
Salcido-García et al[18]	2,241	2 to 55y	Radiographic	Facultad de Odontología UNAM (Mexico)	1.6%
Kaller[6]	3,523	4 to 18y	Clinical and radiographic	Los Barrios Community Clinic – Hispanic area of Dallas (USA)	2.2%
Huang et al[5]	543	2.5 to 7y	Clinical and radiographic	Chang Gung Memorial Hospital (China)	7.8%
Present study	**1,995**	**4 to 13y**	**Radiographic**	**Universidade de São Paulo (Brazil)**	**1.5%**

of the mandible as a base line. The maxillary lateral incisor was considered as presenting microdontia when the maximal mesiodistal crown diameter was smaller than that of the opposing mandibular lateral incisor in the same patient.[19] This category also included conical maxillary lateral incisors.

The prevalence of dental anomalies in the sample was compared with reference values for the general population by means of the chi-square test (χ^2), with the significance level set at 5% ($P < 0.05$). The odds ratio (OR) was calculated with 95% of confidence intervals to measure the strength of associations between supernumerary mesiodens and the presence of other dental anomalies.

RESULTS

The prevalence rate of mesiodens in the sample corresponded to 1.5% with a male-female ratio of 1.5:1 (Tables 1 and 2). Among the affected patients, 80% had only one mesiodens and 20% had two mesiodens (Table 3). Three out of four mesiodens were unerupted and in an upright position (facing the oral cavity), and more than 80% had extraction indication (Table 5). The most common complications related to mesiodens included delayed eruption of maxillary central incisors and midline diastema (Table 5). No association was found between mesiodens and other dental anomalies, except for maxillary lateral incisor agenesis (Tables 6).

DISCUSSION

This study retrospectively assessed the complete orthodontic records of 1,995 patients who presented deciduous or mixed dentition at orthodontic treatment onset. A total of 36 mesiodens were diagnosed in 30 patients (average of 1.2 mesiodens per patient), corresponding to 1.5% of the overall sample. This prevalence was similar to that described in studies by Hurlen and Humerfelt[17] (1.4%) and Salcido-García et al[18] (1.6%), and is very close to the mean frequency observed for the prevalence values compiled in Table 1 (1.67%).

With regard to sex distribution, mesiodens was more common among males, with a male to female proportion of 1.5:1 (Table 2), which corroborates previous reports.[5-10,14] A retrospective study carried out in India,[8] on a sample of 30 patients with mesiodens, found the same male to female proportion of 1.5:1, whereas a proportion of 2:1,[9] 2.5:1[5] and even 4:1[7] male-female proportions have been described in other studies. Sexual differences in the prevalence of mesiodens disagreed with what has been found for tooth agenesis. Tooth agenesis is more frequent among females, at an approximate proportion of 2:1.[19,25]

Table 2 - Gender distribution of the sample comprised of children with mesiodens.

Sex	Number of individuals	%
Male	18	60
Female	12	40
Total	30	100

Table 3 - Number of mesiodens per patient in the sample.

Number of mesiodens	Number of individuals	%
1	24	80
2	6	20
Total	30	100

Table 4 - Eruption condition, position and treatment planning for mesiodens in the sample.

Eruption condition	Number of mesiodens	%
Unerupted	27	75
Erupted	9	25
Total	36	100
Position	**Number of mesiodens**	**%**
Normal	27	75
Inverted	5	13.9
Horizontal	4	11.1
Total	36	100
Treatment	**Number of mesiodens**	**%**
Extraction	31	86.1
Follow-up	5	13.9
Total	36	100

Table 5 - Complications associated with mesiodens in the sample.

Complications	Number of cases (%)
Delayed eruption of maxillary permanent incisors	12 (34.28%)
Midline diastema	10 (28.57%)
Rotation or axial inclination of erupted permanent incisors	6 (17.14%)
Resorption of teeth adjacent to mesiodens	1 (2.85%)
Root anomaly	2 (5.57%)
None (asymptomatic)	4 (11.42%)
Total	35 (100%)

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A single mesiodens was found in 80% of the sample, whereas the remaining 20% presented two mesiodens (Table 3). A very similar proportion was described in a clinical and radiographic study involving 90 patients and 113 mesiodens,[10] in which the majority of patients (78%) had a single mesiodens while the remaining patients had two. Kim and Lee[7] described a similar tendency with 75% of patients exhibiting only one mesiodens and 25% exhibiting two mesiodens. A patient with three mesiodens was described in a retrospective study involving Japanese children.[3]

Among the 36 mesiodens in the sample, 27 (75%) were unerupted while nine (25%) had erupted in the oral cavity (Table 4). Studies are unanimous in demonstrating that the majority of mesiodens remains impacted[6,8-10,14,18] and are often discovered only in routine radiographs requested for other reasons.[9] Mesiodens may also be identified in radiographs requested for follow-up of maxillary incisors trauma or due to delayed eruption of maxillary permanent incisors. These factors are the most common causes of mesiodens diagnosis.[9]

A mesiodens is most often in an upright position with the crown facing the oral cavity (normal position), but mesiodens can be found in inverted or even in a horizontal position.[4,5,9,14] In the present sample, the normal position (vertical, with the crown positioned towards the oral cavity) was found in 75% of the cases, followed by the inverted and horizontal positions (Table 4), which is in agreement with the literature.[4,9,14] These results, however, diverge from a study carried out with Korean children, in which the most common direction was the upright position with the crown facing the nasal cavity (inverted) observed in 52% of the sample, followed by normal (38%) and horizontal (10%) positions.[7] This same tendency was found in a sample of 200 Japanese children with 256 mesiodens, in which the inverted position (67%) predominated over normal (27%) and horizontal (6%).[3]

The most common treatment planning for mesiodens is extraction.[4,7] The removal of mesiodens in the deciduous dentition is not generally recommended due to the risk of injuring the developing maxillary incisors as well as due to lack of patient

Table 6 - Prevalence of dental anomalies in the sample compared with reference values.

Dental Anomaly	Prevalence rate in the sample	n	Reference values	n	χ^2	P	Odds Ratio	Confidence interval	
Tooth agenesis (excluding third molars)	10.00%	3/30	5.00% Grahnen[27]	53/1064	1.51	0.219	2.12	0.62	7.21
Mandibular second premolar agenesis	3.33%	1/30	3.00% Polder et al[25]	1479/48274	0.01	0.932	1.09	0.15	8.01
Maxillary second premolar agenesis	3.33%	1/30	1.50% Polder et al[25]	722/48274	0.69	0.407	2.27	0.31	16.70
Maxillary lateral incisor agenesis	10.00%	3/30	1.90% Le Bot and Salmon[28]	109/5738	**10.28**	**0.001**	**5.74**	1.71	19.20
Small maxillary lateral incisor	3.33%	1/30	4.70% Baccetti[21]	47/1000	0.12	0.726	0.70	0.09	5.24
Mandibular second premolar distoangulation	3.33%	1/30	0.19% Matteson et al[29]	52/26264	**14.64**	**<0.001**	**17.38**	2.32	129.99
Palatally displaced canines (PDC)	3.33%	1/30	1.70% Dachi and Howell[30]	25/1450	0.44	0.507	1.97	0.26	15.00
Supernumerary teeth	10.00%	3/30	3.90% Baccetti[21]	39/1000	2.77	0.096	2.74	0.80	9.41

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cooperation during this stage.[4,9] Thus, the clinical and radiographic follow-up can also be indicated in cases in which the mesiodens is not causing a malocclusion or will not interfere in the orthodontic treatment.[9,14] In the present study, 86.1% of the mesiodens were surgically removed right after diagnosis, whereas the remaining 13.5% were followed-up radiographically due to the absence of any interference in the dental development (Table 4).

The main complications associated with mesiodens were: delayed eruption of permanent incisors (34.28%), midline diastema (28.57%) and rotation or axial inclination of permanent incisors (17.14%). Other local disorders were also associated with the presence of mesiodens as shown in Table 5. Similar findings have been previously reported.[7,9,14]

Regarding the presence of other dental anomalies associated with mesiodens, 22 patients (73.3% of the sample) did not exhibit any associated dental anomaly.

The other eight patients (26.7%) exhibited 12 associated dental anomalies including microdontia of maxillary lateral incisors, other supernumerary teeth, delayed development of second premolars, distoangulation of mandibular second premolars and tooth agenesis (Table 6).

The statistical analyses revealed that patients with mesiodens did not have an increased prevalence of permanent tooth agenesis in general or microdontia of the maxillary lateral incisors (Table 6). However, the prevalence of agenesis of maxillary permanent lateral incisors was approximately five times higher in the sample when compared with the general population. This uncommon association between a supernumerary mesiodens and the agenesis of maxillary lateral incisor has been described in a case report previously published and the interpretation of the authors regarding this association was a possible transposition between a malformed lateral incisor and the central incisor.[26]

One patient (3.3%) in the sample exhibited distal angulation of the mandibular second premolars. Due to the small prevalence of this anomaly in the general population (0.19%), this result was considered statistically significant (Table 6). However, considering the small size of the sample, this result could have randomly occurred and should be interpreted with caution. Larger samples are needed to confirm such association.

Ectopic eruption of maxillary canines was diagnosed in one patient. However, since the patient was eight years old and the diagnosis of ectopia in panoramic radiographs is more reliable among patients over the age of 10,[23] this anomaly was not considered.

CONCLUSION

1. The prevalence of mesiodens in the deciduous and mixed dentition corresponded to 1.5%, with a male to female proportion of 1.5:1.
2. Mesiodens was associated with local disorders, such as maxillary incisor rotation, delayed eruption or impaction of maxillary incisors, midline diastema, permanent incisor root resorption and dilaceration.
3. Mesiodens was associated with other dental anomalies in 26.7% of the sample.
4. The prevalence of maxillary lateral incisor agenesis was higher in children with mesiodens in comparison to the general population.

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Applicability of Moyers analysis in mixed dentition: A systematic review

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Introduction: Moyers analysis is widely used for analyzing mixed dentition, however, the accuracy of its theoretical probability tables has been recently questioned. Taking into consideration the fact the mixed dentition analysis is of paramount importance to precisely determine the space needed for alignment of canines and premolars, this research aimed at objectively assessing in the literature such an important step for orthodontic diagnosis.

Methods: A computerized search involving articles published on PubMed and Lilacs between 1990 and September, 2011 was conducted in accordance with the method described in the Cochrane 5.1.0 handbook.

Results: The research resulted in a sample composed of 629 articles. The inclusion criteria were: Articles using the Moyers analysis with a sample greater or equal to 40 patients. Conversely, the exclusion criteria were: Dental casts of patients with syndromes or oral cleft, researches conducted with a literature review, only, or clinical case reports and researches conducted before 1990. For this systematic review, 19 articles were selected.

Conclusion: Based on the literature available, we can conclude that the Moyers mixed dentition analysis must be carefully used, since the majority of the articles analyzed showed that the probability of 75% was not as accurate as expected, leading to the need of adapting the probability levels depending on the study population.

Keywords: Mixed dentition. Malocclusion. Dental eruption.

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INTRODUCTION

A correct diagnosis is the first step towards a successful orthodontic treatment, and mixed dentition analysis[1] is considered a fundamental step to make a good diagnosis.[2,3]

The mixed dentition analysis enables the identification of a tooth size-arch length discrepancy and, according to the results obtained, proposes different treatment approaches such as: Eruption guidance, space regaining, serial extractions or not to intervene by keeping the development of the dentition under observation.[2,4]

The use of an accurate method for predicting the mesiodistal diameter of unerupted canines and premolars is essential when verifying the discrepancy between the size of the teeth and the size of dental arches in mixed dentition.[2] Several methods are used to assess the required space, i.e., to estimate the mesiodistal diameters of unerupted canines and premolars.[1,2,4]

Most methods use the mandibular permanent incisors to predict the sum of mesiodistal dimensions of the canine and premolars, since these incisors are the first to erupt in mixed dentition, have less variability in shape and size, can be easily and accurately measured and have a high correlation with other groups of teeth.[5,6,15]

The Moyers mixed dentition space analysis method is currently the most widely used.[3,4,5,7,8] It established a probability table to predict the mesiodistal diameter of unerupted canines and premolars, in both arches.[9] This table uses the sum of mesiodistal diameters of the four mandibular incisors and, for each value obtained in the sum of the four mandibular incisors, there is a corresponding value for unerupted canines and premolars of each quadrant. It was developed at the University of Michigan from a sample comprising northern European white subjects.[7,9]

The probabilities range from 5% to 95% and the author suggests the use of the table at a level of 75% in order to overestimate the value and avoid potential crowding. According to the author, this method has some advantages, such as: Minimum systematic error, it can be easily and safely used by beginners or specialists, it is fast and does not require the use of radiographies and also may be carried out directly in the mouth.[9]

The purpose of this study was to carry out a systematically review about the effectiveness of Moyers mixed dentition space analysis in predicting unerupted teeth.

MATERIAL AND METHODS

The systematic review was carried out in accordance with the Cochrane Handbook for Systematic Reviews of Interventions 5.1.0.

A computerized search was conducted by means of researching articles published from January 1990 to September 2011 on PubMed (http://www.ncbi.nlm.nih.gov/pubmed/) and Lilacs (http://regional.bvsalud.org/php). The keywords used and the number of articles found are shown in Table 1. The keywords were inserted into the databases without restricting the period of publication of articles. The inclusion criteria were as follows: Sample greater than or equal to 40 dental casts and the use of Moyers mixed dentition space analysis to predict unerupted canines and premolars. Conversely, the exclusion criteria were: Dental casts of patients with some type of syndrome or cleft patients, literature reviews, clinical case reports and researches carried out prior to 1990.

Two reviewers independently assessed all the articles abstracts. All abstracts meeting the initial inclusion criteria were selected, those that did not provide enough information to determine their suitability to the inclusion criteria were selected too, so that the final decision would be made with the complete article.

RESULTS

The research resulted in a sample composed of 629 articles. After analyzing them according to the inclusion/exclusion criteria, 36 articles were selected for analysis, 30 from PubMed database and 6 from Lilacs. The final total number of selected articles was 19, since 17 articles were duplicated in the search results. The number of selected articles and methodological criteria of systematic review are shown in Table 2.

The Kappa index of agreement between reviewers was 1.00.

A total of 610 articles were excluded: 593 by the established criteria and 17 articles because they were the same articles published in different databases. The reasons for exclusion and the number of excluded articles are listed in Table 3. In the Lilacs database, 57 articles

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Table 1 - Strategy for literature research.

Number	Keyword	PUBMED	LILACS
1	Mixed dentition AND Moyers analysis	17	7
2	Prediction of unerupted teeth	59	1
3	Mixed dentition analysis	490	55

Table 2 - Studies included and excluded after reviewers' analyses.

Keyword / PubMed Database	Studies included	Studies excluded	Total
Mixed dentition AND Moyers analysis	9	8	17
Prediction of unerupted teeth	12	47	59
Mixed dentition analysis	9	481	490
Keyword / Lilacs Database	**Studies included**	**Studies excluded**	**Total**
Mixed dentition AND Moyers analysis	3	4	7
Prediction of unerupted teeth	0	1	1
Mixed dentition analysis	3	52	55

Table 3 - Reasons for articles exclusion.

Reasons for exclusion	LILACS	PubMed	Total
Sample with less than 40 subjects	5	3	8
Patients with some type of syndrome or cleft patients	0	4	4
Moyers analysis was not used	4	37	41
Research was not about predicting space	43	392	435
Literature review/case reports	3	4	7
Research conducted prior to 1990	2	96	98
Total of excluded studies	57	536	593

were excluded, while in the PubMed database 536 articles were excluded.

Most articles were excluded because they were not related to prediction of unerupted canines and premolars, followed by articles published out of the stipulated period and by studies that did not use the Moyers analysis.

All 19 articles were entirely read, except for one article written in Chinese which had to be evaluated by the title and abstract in English.

Among 19 articles, only two[14] enabled the use of a probability level of 75% in both arches and for both genders.

In 10 articles,[2-5,7,16-20] the probability table had to be adapted in order to make the Moyers analysis appropriate to their population and, in 7 articles,[8,10-13,15,21] the Moyers mixed dentition space analysis was not suitable for prediction of canines and premolars. Summarized data of the articles are shown in Table 4.

DISCUSSION

A systematic review is a literature review focused on a research question that tries to identify, appraise, select and synthesize all high quality research evidences relevant to that question in order to help our clinical approach.

Inclusion and exclusion criteria for this systematic review were determined with the aim of selecting the most relevant papers on the subject in question, only.

The mixed dentition analysis is a fundamental step that should always be performed in orthodontic diagnosis and planning of patients with mixed dentition.[2,3] The use of an inappropriate method may hinder the entire treatment plan because both overestimation and underestimation of crown diameters of unerupted canines and premolars can influence treatment planning, especially decisions regarding extractions.

Moyers mixed dentition space analysis method is currently the most widely used (1963),[3,4,5,7,8] but recently, its accuracy has been questioned, mainly because its probability table was developed on the basis of a population with a Northern European ancestry.

In recent years, studies have shown that the prediction tables formulated by Moyers is neither accurate nor applicable when applied to a population of different ethnic origin, due to the fact that the values obtained at 75% (as recommended by the author) do not correspond to the real values.[2,3,5,7,12,13,15,19]

The biggest clinical problem exists when, at 75%, the predicted values underestimate the real values, in which case there will not be enough space to properly align the teeth. When the values overestimate the real values, it means that there will be more space to accommodate the posterior teeth, which is not considered a real clinical problem.

Table 4 shows that in several studies, Moyers probability tables underestimated[2,3,4,8,10,15] the real values at 75%. In other studies,[5,7,12,13] the predicted values overestimated the real ones. This means that Moyers mixed dentition space analysis was not appropriate for most populations evaluated.

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Article	Sample and Gender	Population	Outcomes
Boboc and Dibbets[1]	320 (158 ♂ and 162 ♀)	German	Moyers 75% ↑♀ and ♂
Philip et al[2]	600 (300 ♂ and 300 ♀)	Indian	Moyers ↑ 85% and 95% ♂
			Moyers ↑ 85% and 95% ♀ L
			Moyers ↑ 95% ♀ U
Schirmer and Wiltshire[3]	100 (50 ♂ and 50 ♀)	American	Moyers ↓ 5% to 95% underestimated ♂
			Moyers ↑ 85% and 95% ♀
Pereira Neto et al[4]	40 (20 ♂ and 20 ♀)	Brazilian	Moyers ↑ 75% L ♀ and ♂
			Moyers ↑ 95% U ♀ and ♂
Farret et al[5]	100 (55 ♂ and 45 ♀)	Brazilian	Moyers ↑ 65% L ♀ and ♂
			Moyers ↑ 65% and 75% U ♀ and ♂
nik Tahere et al[7]	50 (25 ♂ and 25 ♀)	Iranian	Moyers ↑ 65% U and L ♂
			Moyers ↑ 75% and 85% U ♀
			Moyers ↑50% and 65% L ♀
Cabral and Pessôa[8]	60 (30 ♂ and 30 ♀)	Brazilian	Moyers ↓ underestimated 50% ♀ and ♂
Wang et al.[10]	140	Chinese	Moyers ↓ underestimated
Jaiswal et al.[11]	200 (100 ♂ and 100 ♀)	Nepalese	Moyers ↓ underestimated 50% ♂
			Moyers ↓ overestimated 50% ♀
Durgekar and Naik[12]	150 (75 ♂ and 7 5 ♀)	Indian	Moyers ↓ 75% ♀ and ♂ overestimated
			Moyers ↓ 50% ♂ overestimated L
			Moyers ↓ 50% ♂ underestimated U
			Moyers ↓ 50% ♀ underestimated L
			Moyers ↓ 35% ♀ and ♂ underestimated
Verzì et al[13]	150 (68 ♂ and 82 ♀)	Italian	Moyers ↓ overestimated 75% ♀ and ♂
de Paula et al[14]	40 (20 ♂ and 20 ♀)	Brazilian	Moyers 75% ↑ ♀ and ♂
van der Merwe et al[15]	200 (73 ♂ and 127 ♀)	African	Moyers ↓ 5% to 95% underestimated
Memon and Fida[16]	121 (45 ♂ and 76 ♀)	Pakistani	Moyers ↑ 50% ♂
			Moyers ↑ 75% ♀
Abu Alhaija and Qudeimat [17]	226 (130 ♂ and 96 ♀)	Jordanian	Moyers ↑ 75% U ♂
			Moyers ↑ 65% L ♂
			Moyers ↑ 85% U and L ♀
Hashim and Al-Shalan [18]	65 (37 ♂ and 28 ♀)	Arab	Moyers ↑ 50% ♀ and ♂
Flores-Mir et al[19]	248 (131 ♂ and 117♀)	Peruvian	Moyers ↓ 5% to 95% L ♂
			Moyers ↑ 65% U ♂
			Moyers ↑ 95% L ♀
			Moyers ↑ 65% L ♀
al-Khadra[20]	34 (not informed ♀ and ♂)	Arab	Moyers 35% ↑ ♀ and ♂
Diagne and Diop-Ba[21]	50 (25 ♂ and 25 ♀)	Selegalese	Moyers 50% ↓ Underestimated ♀ and ♂

Table 4 - Summarized data of the 19 articles included in this review.

↑ = High correlation of real values with the values found after Moyers analysis.

↓= Low correlation of real values with the values found after Moyers analysis.

♀ = Female.

♂ = Male.

U = Upper arch.

L = Lower arch.

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For the Brazilian population, at 75%, the Moyers analysis overestimated the real values in one article (Farret et al[5]), underestimated the real values in another article (Cabral and Pessôa[8]), and was appropriate in two articles (De Paula et al[14])and for the lower arch, only, in one article (Pereira Neto et al[4]).

Due to the wide variability of results found for the Brazilian population, perhaps the use of a different method is necessary to evaluate mixed dentition space in Brazilian subjects.

CONCLUSIONS

Based on our systematic review, it seems that the use of Moyers mixed dentition analysis should be used carefully, because, in the majority of the articles examined, its accuracy regarding probability level at 75% was poor. Therefore, we suggest that the probability tables be adapted according to each population, or that another method be used to predict unerupted permanent canines and premolars.

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Assessment of first molars sagittal and rotational position in Class II, division 1 malocclusion

Paulo Estevão Scanavini[1], Renata Pilli Jóias[2], Maria Helena Ferreira Vasconcelos[3], Marco Antonio Scanavini[4], Luiz Renato Paranhos[5]

Objective: This study assessed the anterior-posterior positioning of the upper and lower first molars, and the degree of rotation of the upper first molars in individuals with Class II, division 1, malocclusion.

Methods: Asymmetry I, an accurate device, was used to assess sixty sets of dental casts from 27 females and 33 males, aged between 12 and 21 years old, with bilateral Class II, division 1. The sagittal position of the molars was determined by positioning the casts onto the device, considering the midpalatal suture as a symmetry reference, and then measuring the distance between the mesial marginal ridge of the most distal molar and the mesial marginal ridge of its counterpart. With regard to the degree of rotation of the upper molar, the distance between landmarks on the mesial marginal ridge was measured. Chi-square test with a 5% significance level was used to verify the variation in molars position. Student's t test at 5% significance was used for statistical analysis.

Results: A great number of lower molars mesially positioned was registered, and the comparison between the right and left sides also demonstrated a higher number of mesially positioned molars on the right side of both arches. The average rotation of the molars was found to be 0.76 mm and 0.93 mm for the right and left sides, respectively.

Conclusion: No statistically significant difference was detected between the mean values of molars mesialization regardless of the side and arch. Molars rotation, measured in millimeters, represented ¼ of Class II.

Keywords: Molar tooth. Angle Class II malocclusion. Orthodontics.

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INTRODUCTION

Dental arch symmetry and dimension are of great interest for orthodontists when making diagnosis and treatment planning.[1,2]

Molar positioning in the anterior-posterior direction determines the sagittal classification of malocclusion[3,4] and can be easily detected in cases of Class II subdivision. However, molar positioning should also be considered in cases of bilateral malocclusion, since a molar more mesially positioned on one side, even if not clinically[2] apparent, can influence diagnosis, treatment planning and,[5-8] especially occlusal stability.

The asymmetric position may determine important aspects regarding the orthodontic mechanics that will be used, such as the correction of rotations, or distalization methods.[9-12] These procedures may be applied with different intensities in each to obtain an arch with symmetrical positioning of the posterior teeth.[13] With the purpose of carrying out a detailed assessment of teeth positioning, the dental cast analysis is an important tool due to its practicality, reliability and reproducibility.[1,14-20]

Thus, this study aimed at assessing the positioning of contralateral molars in the maxillary and mandibular arches in the anterior-posterior direction, as well as to examine the degree of rotation of the upper molars in individuals with Class II, division 1 malocclusion.

MATERIAL AND METHODS

This research was previously approved by the Institutional Review Board of the Metodista University of São Paulo (UMESP), under protocol number 0210135. The sample of this study was obtained from the files of the Postgraduate Program of the aforementioned University. Sixty sets of plaster models from 27 females and 33 males, aged between 12 and 21 years, with Class II, division 1 malocclusion, were selected.

Measurements were made directly in the study models by using Asymmetry I, a device developed in the Postgraduate Program Department to enable the visualization of the sagittal positioning of molars as well as the existence of possible rotations. This device consists of a structure similar to a parallelometer, containing: A base for positioning the model, a transparent horizontal acrylic plate with a millimeter ruler, and a rod which enables the identification of the molars positioning (Figs 1A and B).

The midpalatal suture was used as a symmetry reference.[1,2] It was delimited in the maxillary arch by demarcating landmarks over the mid-palatal suture from the incisive papilla until the most posterior visible landmark.[19,20] The symmetry axis was obtained by connecting these landmarks. Then, it was extended anteriorly up to the incisal edge of the maxillary incisor to determine the landmark As (anterior-superior). Conversely, it was posteriorly extended up to the posterior surface of the maxillary model to determine Ps (posterior-superior) (Fig 2A).

The midline projection, obtained in the maxillary arch, was used when the midpalatal suture was transferred to the lower model.[15,16] The upper midline was transferred to the lower model by using the reference landmarks As and Ps.

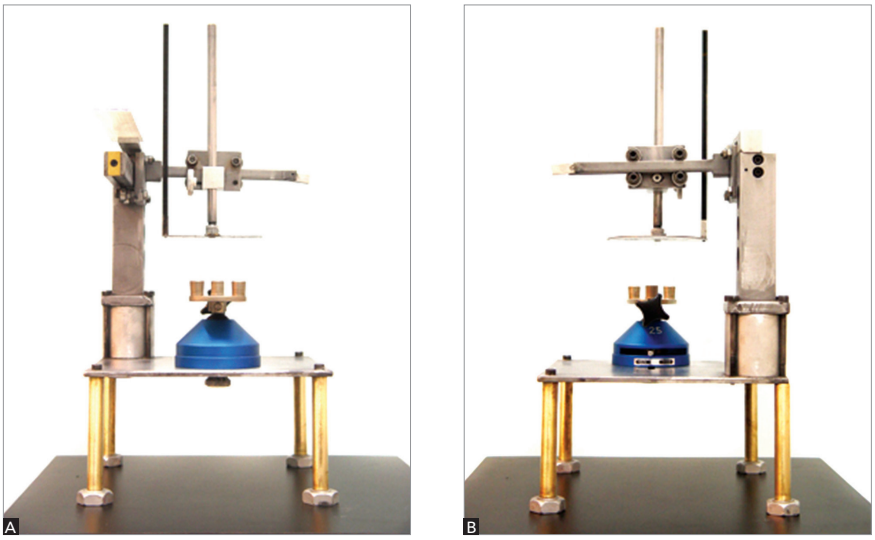


Figure 1 - Measuring device - Asymmetry I -, frontal view (**A**); posterior view (**B**).

The models, properly trimmed, were placed in occlusion, so that the posterior surfaces matched in the same plane. The landmark Ps of the upper model was transferred to the lower model by means of a set triangle ruler positioned perpendicularly to the base of the lower model, thereby determining the landmark Pi (posterior-inferior) on the lower model (Fig 2B).

With the models still in occlusion and with the set triangle ruler equally placed anteriorly to the models matching with the landmark As of the upper model, the landmark Ai (anterior-inferior) was demarcated in the mandibular model (Fig 2C).

Obtaining and connecting Ai and Pi landmarks enabled the lower midline to be determined (Fig 2D).

The models were then placed onto the base of the parallelometer which was fixed to the base of the Asymmetry I device (Figs 3A and B). When positioning the models, the occlusal surface of the teeth should be parallel to the horizontal plane, and the protractor pointer positioned over the midpalatal suture. The reference used for assessing the molar positioning was the mesial marginal ridge. Subsequently, the distance between the mesial marginal ridge positioned more distally and the mesial marginal ridge of the opposite molar was measured in the longitudinal direction, as shown in Figures 4 and 5.

In order to verify the possible association of variation in molar positioning, concerning the arch and side of the molars mesially positioned, chi-square test (c^2) was used. Student's t test was employed to compare these values. In all tests, a significance level of 5% was adopted.

In addition to assessing the position of the molars in the anterior-posterior direction, the degree of rotation of the upper molars was also assessed, as follows: the distance between the most mesial portion of the mesial marginal ridge toward the mesiodistal sulcus (point CM), and the apex of the mesiobuccal cusp, at its most mesial portion, was measured. One horizontal line was projected from the CM landmark, and another from the VM landmark, both parallel. Thus, the distance between these lines was measured, in millimeters, indicating the rotation of the molars in the mesiodistal direction (Fig 6).

RESULTS

Table 1 shows the distribution of the individuals comprising the sample, considering the side of the molar mesially positioned and the dental arch.

The variation in the mean value of molar mesialization was found to be 0.05 mm for the maxillary arch, with mean values of 1.55 mm and 1.50 mm for the left and right sides, respectively. For the mandibular arch, this

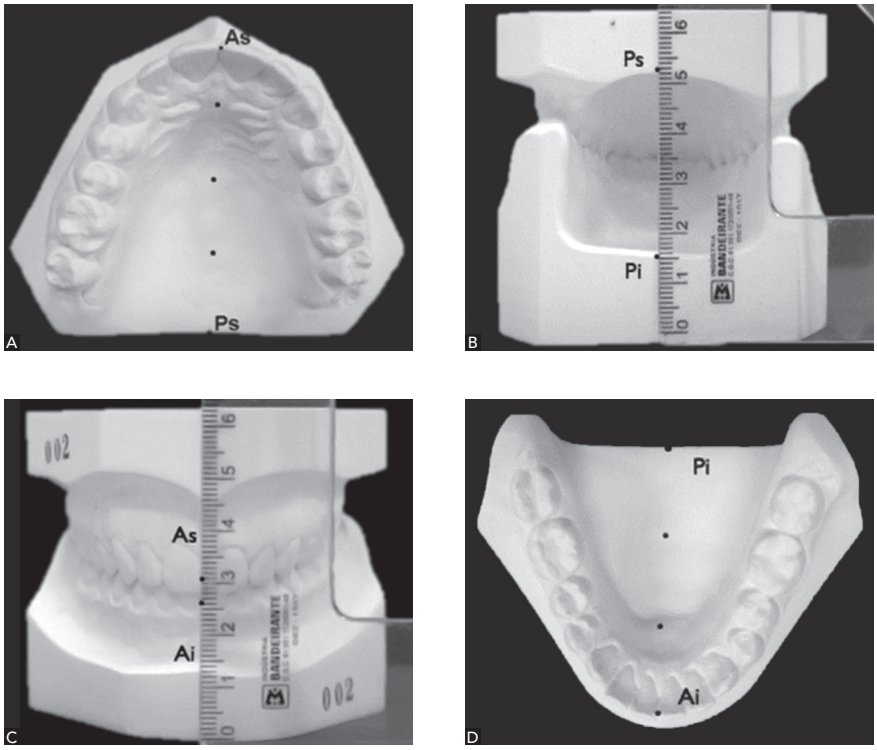


Figure 2 - A) determination of the upper midline (landmarks As and Ps); B) transference of the Ps to the lower model - obtaining PI; C) transference of the As landmark to the lower model – obtaining Ai; D) determination of the lower midline (landmarks Ai and Pi).

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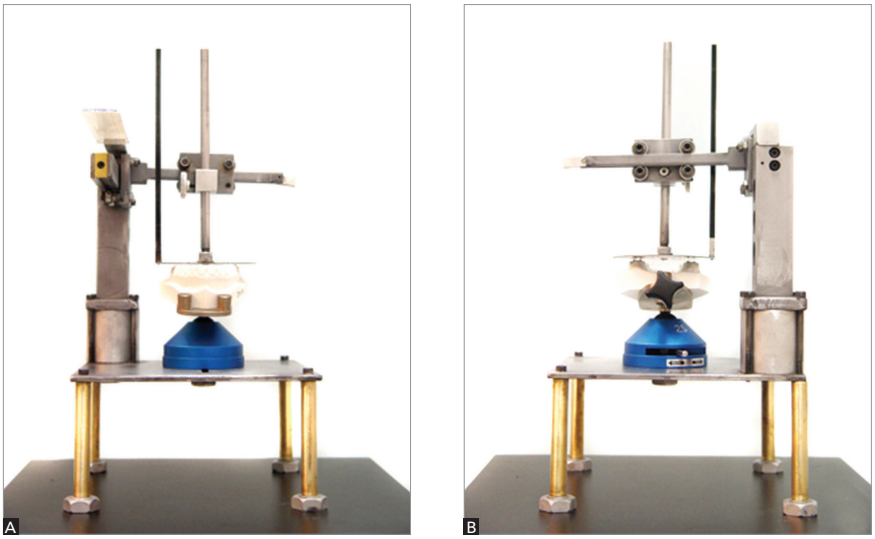


Figure 3 - Models positioned for measurement: **A)** front view, **B**) back view.

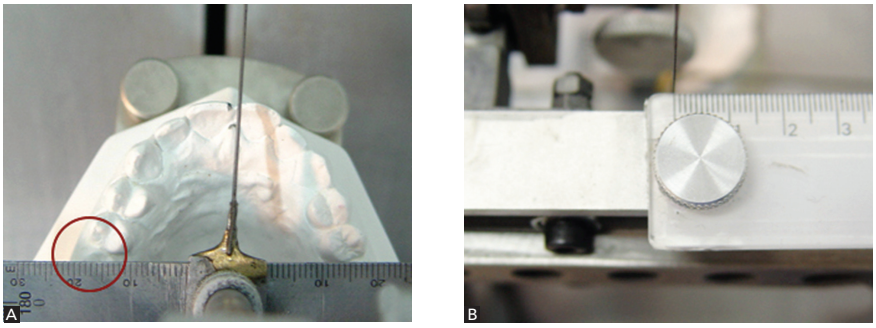


Figure 4 - **A**) Model positioned evidencing the more mesial position of the maxillary right first molar, in relation to left-side counterpart; **B**) ruler recording the position of the right maxillary first molar at zero position.

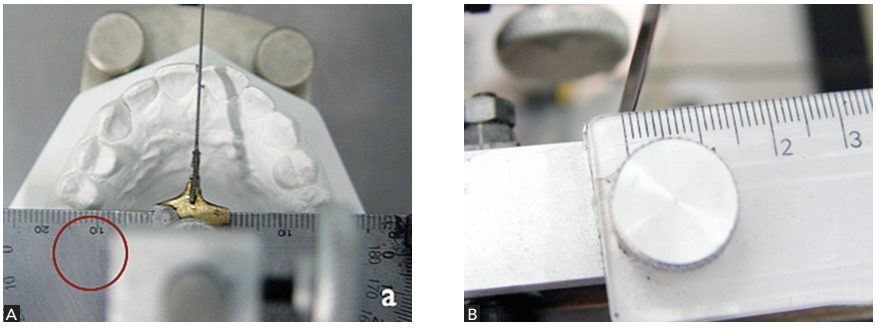


Figure 5 - **A**) Device positioned on the mesial marginal ridge of the right maxillary first molar **B**); ruler registering the most mesial position of the right maxillary first molar by 1.5 mm, in relation to left-side counterpart.

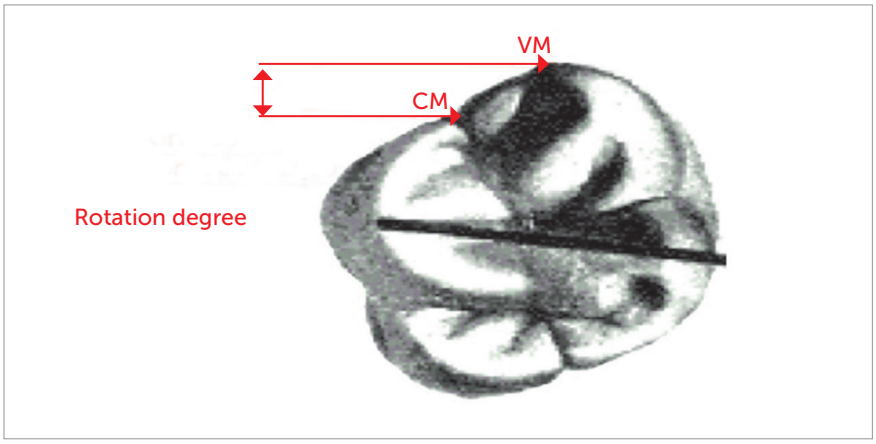


Figure 6 - method used to assess the rotation of the first maxillary molars.

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variation was 0.45 mm, with mean values of 2.19 mm and 1.74 mm for the left and right sides, respectively. Table 2 shows the mean values and respective standard deviation of molar mesialization with regard to the arch and side. The *t* test indicated no significant difference in the respective comparisons.

With regard to the rotation of the upper molars, mean rotations of 0.76 ± 0.37 mm and 0.93 ± 0.53 mm were observed for the right and left molars, respectively, and a mean rotation of 0.85 ± 0.45 mm was observed between both sides.

DISCUSSION

The models used herein were assessed by a device exclusively developed for the dental arch asymmetry analyses. It was carefully designed not only to allow the models to be positioned on a flat surface, but also to observe the inclination of the occlusal plane. Additionally, it was used a small-caliber rod (0.5 mm) to avoid improper interferences on the measurements.[14-17]

In order to achieve more accurate and standardized measures, the models were placed onto a parallelometer base fixed to the base of the device, considering the midpalatal suture as a symmetry reference.[1,2] The occlusal surfaces of the teeth on the models were leveled to the horizontal plane by means of a leveling board. Two-millimeter rulers were adapted, one on the protractor base, and the other on the upper part of the device as a way to measure the positioning and degree of rotation of the molars. The part of the device where the protractor with the pointer was fixed could move in transverse and longitudinal directions, through a set of rollers, causing the measurements to be easily and agilely obtained, thus, permitting higher reliability and standardization — once the models remained static after been positioned, and only the protractor with the pointers could move.

The analysis of the results demonstrated that the comparison between maxillary and mandibular arches showed a great number of lower molars more mesially positioned, corroborating the literature,[15,21,22] while the comparison between the sides showed a higher number of molars mesially positioned on the right side of both arches.

The mean values regarding variation in molar mesialization suggest that the sample of this study showed greater variation in molar positioning in the mandibular arch, which leads to a high incidence of asymmetry. This fact occurs because the mesialization of a molar in relation to its counterpart reveals an asymmetric positioning of these teeth, which can also indicate asymmetry in the respective dental arch. Although numerical differences were observed with regard to the sagittal positioning of these molars, our results pointed out that the mean values and standard deviation of molar mesialization have no significant difference when compared between the arches, neither when compared to the side of the molar mesially positioned. These findings are in disagreement with those of other authors[15,16,21] who assessed dental asymmetry in individuals with the same malocclusion and found significant differences between the maxillary and mandibular arches.

Asymmetric positioning of molars can be attributed to genetic, postural, chewing and harmful habits.[1,6,7,21] A correct diagnosis and adequate treatment planning are of paramount importance for obtain-

Table 1 - Distribution of the individuals comprising the sample considering the side of the molar mesially positioned and arch.

Mesialization	Arch			
	Maxillary		Mandibular	
	n	%	27	45,0
Right molar	21	35.0	27	45.0
Without mesialization	29	48.3	17	28.3
Left molar	10	16.7	16	26.7
Total	60	100.0	60	100.0

χ^2 = 5.27; p = 0.072 (non-significant difference).

Table 2 - Mean value and standard deviation of molar mesialization with regard to the arch and side, and t test values for the respective comparisons.

	Left	Right	Comparison between sides	
	Mean ± SD	Mean ± SD	t	p
Maxillary	1.55 ± 0.76	1.50 ± 0.50	0.219	0.828 (ns)
Mandibular	2.19 ± 1.12	1.74 ± 0.96	1.381	0.175 (ns)
Comparison between the arches	t = 1,576; p =0.128 (ns)	t = 1.039; p = 0.304 (ns)		

ns – non-significant difference.

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ing a stable occlusion at retention and post-retention stages. In addition, achieving a symmetrical positioning of molars at an early stage of the orthodontic treatment favors the success of such a treatment.[6,7,8]

With regard to factors that possibly influence the asymmetric positioning of molars, the rotation of maxillary molars was assessed. This rotation may indicate an increased length of the maxillary dental arch, besides being responsible for the Class II relationship of molars. Accordingly, it is justified the need to assess the rotation of the first maxillary molars, once the degree of rotation may determine the level of Class II malocclusion. The correction of rotation of the first maxillary molars can even transform a Class II molar relationship into a Class I molar relationship, depending on the degree of rotation of the first maxillary molars.

This study aimed at assessing the rotation of molars in millimeters, i.e., foreseeing the space that would be gained in the dental arch so that the molars would be driven to the ideal position. The mean values of rotation of the molars were found to be 0.76 mm and 0.93 mm for the right and left molars, respectively.

In general, the literature quantifies Class II into ¼ or ½ Class II, or full Class II. Taking into account that the average mesiodistal width of an upper molar is 10.41 mm[23] and that the average rotation of the molars was 0.84 mm, it was possible to understand that the molar rotation observed herein, when singly considered, would correspond to ¼ of Class II.

CONCLUSION

In conclusion, the results obtained by the methodology applied showed that:

- No significant difference was detected between the mean values and standard deviation of the molars mesialization when compared per side (right and left) and per arch (maxillary and mandibular);
- When singly observed, the molar rotation, quantified in millimeters, accounted for ¼ of Class II.

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Prototype of a new tip developed to be coupled to dental light-curing units for optimizing bonding of orthodontic brackets and accessories

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Objective: development of a new device to be coupled to light-curing units for bonding orthodontic brackets and accessories, and test its efficacy in an in vitro mechanical trial. The inner surface of the device is mirrored and is based on physical concepts of light refraction and reflection. The main advantage of such device is the reduced clinical time needed for bonding and the low possibility of contamination during the process.

Methods: One hundred and twenty specimens were used for testing the shear bond strength of brackets bonded with the device. The Adhesive Remnant Index (ARI) was also determined. The sample was divided into 2 groups. In group 1 a halogen light-curing unit was used while in group 2 a led light-curing unit was used. Each group was then subdivided. In subgroups H1 and L1, a conventional light guide rod was used while in subgroups H2 and L2 bonding was performed with the mirrored device coupled to the tip of the guide light rod.

Results: The values obtained for the shear bond strength and the ARI in the subgroups were compared. Results showed that there was no statistically significant difference for the shear strength ($p > 0.05$) and the ARI ($p > 0.05$) between the subgroups.

Conclusion: The tests of mechanical trials and the ARI analysis showed that the new device fulfilled the requirements for bonding orthodontic accessories, and that the time for bonding was reduced to half, being necessary only one light exposure.

Keywords: Light-curing of dental adhesives. Orthodontic brackets. Patents. Shear strength.

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INTRODUCTION

The light-emitting sources for light curing of composite resins that are available in the market are halogen lamps, blue light-emitting diodes (LEDs), argon laser and xenon plasma arc.[3,20] Although the latter reduce curing time to one quarter[23] and one third,[24] respectively, in comparison to that afforded by conventional curing units, the machines are costly, which hampers their use in private dental offices.[23,24]

LED is the acronym for Light-Emitting Diode, a semiconductor diode which, when energized, emits visible light through luminescence and not through a heated filament, consuming less power and producing less heat.[18,19,20] Halogen light curing units have been replaced by LED units[2,18] due to its small number of components and lower power consumption.[6,18]

In Orthodontics, bonding brackets and accessories is time-consuming[3] and humidity control is difficult, which may lead to contamination of the enamel surface and consequent bonding failure.[21]

Based on the present conditions for bonding brackets and orthodontic accessories, combined with concepts of Optical Physics, this study aimed at developing and testing a new model of curing unit-adjusted tip, with the purpose of reducing time, achieving better quality and reducing power consumption during the bonding procedure in Orthodontics.

MATERIAL AND METHODS

Based on the existing models of curing units, of which tip contains an optical fiber filament, we developed a mirrored concave tip, based on the fact that spherical concave mirrors are polished caps which are reflective in their inner surfaces. The tip we developed (Fig 1A – upper view, 1B – lateral view) is adjusted to the tips of conventional curing units (Fig 2).

The filing of the patent application was registered with the National Institute of Industrial Property (*Instituto Nacional da Propriedade Industrial* – INPI) under the number 020110074054.

The Committee of Ethics in Animal Experimentation of the Federal University of Juiz de Fora (UFJF) approved this research project (protocol nº 025/2010).



Figure 1 - **A**) Upper view, **B**) Lateral view of the new developed tip.

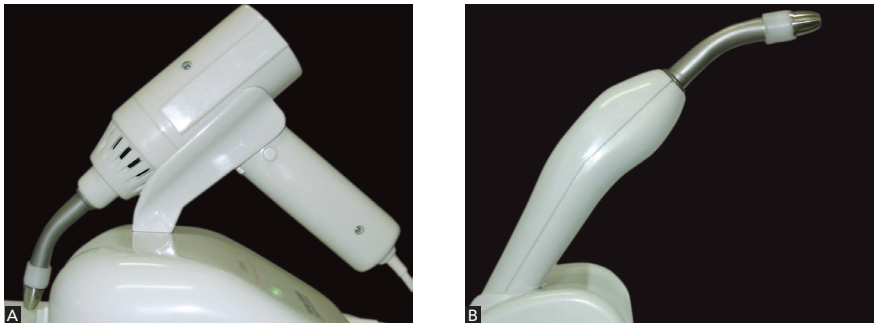


Figure 2 - **A**) Halogen light curing unit with coupled tip; **B**) LED curing unit with coupled tip.

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In order to assess the performance of the tip in orthodontic bonding, we carried out the mechanical trial of shear bond strength and the analysis of the adhesive remaining index (ARI) due to their morphological and histological similarity to human teeth, 120 bovine mandibular incisors were used in this in vitro study.[11,17,22] The teeth were selected with a stereomicroscope (Stemi 2000 – C, Zeiss), at the Modern Physics Department of the Sciences Institute of the Federal University of Juiz de Fora (UFJF).

Two groups of 60 teeth each were formed. Group 1 comprised teeth of which bracket bonding was performed with a halogen-light curing unit (Dabi Atlante Ultralux), while for group 2, a LED-source curing unit (Dabi Atlante Ultraled) was used. Each group was subdivided in 2 subgroups, with 30 teeth each. In subgroups H1 and L1, the conventional tip was used, while in subgroups H2 and L2 the experimental tip we developed was used.

Bracket bonding was performed according to the instructions of the manufacturer of the composite resin (3M Transbond XT®). 120 brackets were used (Dental Morelli, reference 10.30.201).

In subgroup H1, the mesial and the distal surfaces were exposed to light for 10 seconds each. In subgroup L1, the mesial and distal surfaces were exposed to light for 5 seconds each. Light exposure was 10 seconds in subgroup H2 and 5 seconds in subgroup L2. Bonding in group 1 happened with the light held 5 mm away from the bracket-tooth interface, with an incidence parallel to the bonding surface. In group 2, the tip was positioned so as to embrace the bracket in a single incidence.

The bodies of proof for testing shear resistance were assembled[15] in a Universal Testing Machine, EMIC – DL 10000, equipped with a 50Kgf Trd 21 load cell, software Tesc version 3.04 of the Military Institute of Engineering– Rio de Janeiro – LEM DE/4. After the mechanical trial was performed, the ARI for each body of proof was determined with the Stemi 2000 – C stereomicroscope (Zeiss). The ARI indices were classified into 4 scores,[1] as shown in Table 1.

RESULTS

Table 2 shows mean values and standard deviation of each subgroup (H1, H2, L1 and L2).

Student's t test was used for comparison between subgroups. The p value for comparison between H1-H2 and L1-L2 was 0.365 and 0.176, respectively, thus, showing no statistically significant difference between the subgroups.

Figure 3 shows the distribution of values regarding the shear resistance test between groups.

The ARI distribution for each group is shown in Figure 4. The Kruskal-Wallis test was used for ARI statistical analysis. With $p > 0.05$, no statistically significant difference between groups was found.

Table 1 - Criteria for using ARI, according. (Source: Årtun et al,[1] 1984).

ARI – Adhesive Remaining Index	
Score	**Frequency of remaining adhesive**
0	No adhesive remaining on the dental enamel
1	Less than half of the adhesive remaining on the dental enamel
2	More than half of the adhesive remaining on the dental enamel
3	The entire adhesive remaining on the enamel, with distinct impression of the bracket mesh

Table 2 - values of shear resistance tests in MPa.

Subgroup	n	Mean ± SD
H1	30	9.89 ± 5.36
H2	30	9.01 ± 5.61
L1	30	7.01 ± 4.26
L2	30	7.63 ± 5.48
Total	120	

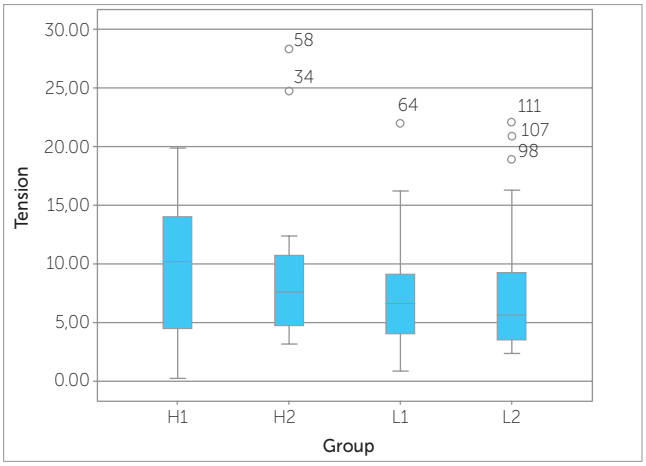


Figure 3 - Box plot diagram of shear resistance in MPa for each subgroup.

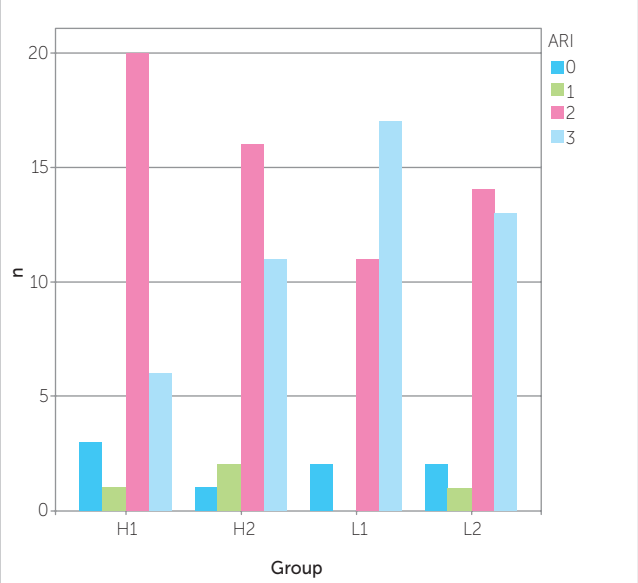


Figure 4 - Bar chart for each group, with regard to ARI incidence.

DISCUSSION

Aiming at reducing orthodontic bonding time, we developed a tip that can be coupled to curing units. This device is based on the concepts of curing unit light refraction and reflection. When visible light reaches the end of the optical fiber of the curing unit, it changes from one medium (optical fiber) to another (air), and the light ray is refracted into a medium with a lower refractive index. This refracted ray is no longer dissipated across the medium, but reflected by the inner mirrored wall of the new device. Because the new tip converges towards the bracket-tooth end, the light rays reach the composite resin in the mesial, distal, incisal/occlusal and gingival directions simultaneously, which reduces curing time up to ¼ of the time recommended by the manufacturer of traditional tips.

One of the disadvantages of using light-curing composite resins is the high number of steps that are necessary during bonding, which increases working time and the likelihood of errors and contamination during the procedure.[5,7,10,12,13,14,16] With the new tip, bonding time was reduced, consequently reducing errors caused by saliva contamination.

For subgroups H1 and L1, variation of light exposure time was in accordance with the recommendations given by the manufacturer of the 3M Transbond XT® composite resin, while for subgroups H2 and L2 it was half the time proposed by the manufacturer. The recommended times are: 20 seconds for an halogen source (10 seconds for the mesial surface and 10 seconds for the distal surface) and 10 seconds for a LED source (5 seconds for the mesial surface and 5 seconds for the distal surface).

Bond resistance corresponds to bond strength divided by the bonding interface area (mm^2). The bracket/adhesive system must resist to a minimum force of 6 MPa (megapascal) to be considered clinically successful.[4,8,9,14] All groups in this study had a mean value greater than what is required for orthodontic success.

As for the ARI assessment, the Kruskal-Wallis test showed no statistically significant difference between groups ($p > 0.05$). The majority of bodies of proof from each subgroup scored 2 or 3, with most of the adhesive remaining on the enamel surface, thus indicating that rupture occurred in the adhesive/bracket interface and not in the enamel/adhesive interface, as expected after adequate light curing.

Therefore, the shear test results and the ARI results proved both bonding techniques, either carried out with the conventional tip or with the tip developed in this study to be efficient.

CONCLUSIONS

1 – Both the mechanical trials and the ARI analysis showed that the new tip met the necessary requirements for bonding orthodontic accessories;

2 – Bonding time was reduced by half, and only a single incidence was necessary.

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Pain, masticatory performance and swallowing threshold in orthodontic patients

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Objective: The aim of this study was to assess pain, masticatory performance and swallowing threshold of patients undergoing orthodontic treatment.

Methods: Ten patients of both genders (mean age of 17.25 ± 5.21 years), with complete permanent dentition, who underwent orthodontic treatment with fixed appliances were evaluated. The masticatory performance and the swallowing threshold were assessed by patient's individual capacity of fragmenting an artificial test food (Optocal) which was chewed and had the resulting particles processed by a standardized sieving method, presenting the median particle size (MPS) of crushed units. The intensity of pain / discomfort during chewing was evaluated by means of a visual analog scale. All tests were performed at the following times: T_0 – before activating the orthodontic appliance; T_1 – 24 hours after activation, and T_2 – 30 days after activation.

Results: The results showed a significant increase in pain at T_1 (T_0 – 0.60 ± 0.70 mm; T_1 – 66.2 ± 34.5 mm), returning to baseline values at T_2 (3.20 ± 3.82 mm). Masticatory performance was also reduced in T_1 (MPS 10.15 ± 1.1 mm^2) in comparison to T_0 (MPS 7.01 ± 2.9 mm^2) and T_2 (MPS 6.76 ± 1.3 mm^2). However, particle size was not affected in the swallowing threshold test (T_0 – 5.47 ± 2.37 mm^2; T_1 – 6.19 ± 2.05 mm^2; T_2 – 5.94 ± 2.36 mm^2).

Conclusion: The orthodontic appliances did not interfere in the size of the particles that would be swallowed, even in the presence of pain.

Keywords: Mastication. Malocclusion. Orthodontics.

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INTRODUCTION

Orthodontic movement pain is caused by the release of different mediators after the application of forces on the periodontal ligament (PDL). These mediators, including substance P, histamine, serotonin, glutamate, prostaglandins, leukotrienes, and cytokines may activate nociceptors within the PDL resulting in orthodontic pain,[1] which usually lasts for 2 or 3 days and gradually reduces by the 5th or 6th day.[2] Studies report that 95% of orthodontic patients experience some pain during treatment and several methods have been used to reduce these symptoms, including low level laser, transcutaneous electric stimulation, vibratory PDL stimulation and use of anti-inflammatory drugs.[1,3,4] Several factors associated with orthodontic pain are still ignored by many clinicians, such as the duration, intensity and functional limitations possibly induced by this symptom.

It has been shown that almost all orthodontic patients report moderate to extreme difficulties in biting and chewing harder foods, and thus tend to choose a less consistent diet.[1] The orthodontic pain is probably the main responsible for the masticatory limitations associated with fixed appliances. The orthodontic pain occurring within 48 hours is so disturbing that approximately 20 per cent of patients report being awakened at night, some of them take medication, and almost all patients report eating difficulties as a result of pain.[5,6] However, an objective analysis of mastication and deglutition in patients during orthodontic therapy was not performed by previous studies. These analyses are necessary considering that patients normally overestimate their masticatory ability when they are evaluated only by subjective methods. For example, many individuals with a compromised dentition and dentures judge their masticatory function as 'good' while an objective test resulted in values much lower than healthy subjects.[7] Therefore, the aims of this study were to evaluate masticatory performance, swallowing threshold and pain after orthodontic fixed appliance activation.

MATERIAL AND METHODS

Sample

Ten patients of both genders, five males and five females (mean age of 17.25 ± 5.21 years) participated in this study. The following inclusion criteria were considered: Approximately equal number of occlusal units with malocclusions requiring orthodontic treatment, the presence of complete permanent dentition (except third molars), uneventful medical history and good oral health. Bonding of at least 10 teeth in the maxillary arch and 0.014 (NiTi), 0.014 or 0.016-in (stainless steel) archwires ligated with elastomeric rings were used during the experimental period. No extractions were performed during this period. Four individuals had Class I malocclusions, four had Class III and two had Class II. The exclusion criteria were: previous orthodontic treatment and symptoms of temporomandibular joint dysfunction. An informed written consent was obtained from all participants or parents prior to their enrolment in the study. The local Institutional Review Board approved the protocol. The study was carried out at the Department of Orthodontics of the Federal University of Rio Grande do Sul (UFRGS), in Brazil. Sample size was determined on the basis of clinically relevant masticatory performance data obtained from the literature,[8,9,10] with a power of 80%, $\alpha = 0.05$, and 10 individuals were deemed adequate for this longitudinal study in which each patient served as their own control.

Timing of evaluations

The subjects were analyzed at three time points: T_0, at their first consultation, before fixed appliances were installed; T_1, 24 hours after installation and engagement of the first archwire; T_2, 30 days after the first activation and before reactivation of the appliance. The data collected included masticatory performance, swallowing threshold and self-reported pain.

Masticatory performance evaluation

Masticatory performance was evaluated by means of the individual capacity of fragmentation of an artificial test-food (Optocal).[11] Subjects were given 17 cubes (3.0 g) and instructed to chew them for 15 cycles, during which they were visually monitored by a trained examiner who also timed them using a digital stopwatch. After 15 chewing cycles, the particles were spat onto a plastic cup and the mouth was rinsed thoroughly until all particles were eliminated into the cup. The collected fragments were then passed through paper filters to eliminate excess water and then placed in an oven at 60 °C for 20 hours. The dried particles were weighed and placed on a series of 10 stacked sieves with progressively smaller mesh sizes, ranging from 5.6 to 0.71 mm. The sieves were submitted to constant vibration for 5 minutes.

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The contents of each sieve were then weighed on an analytic scale with a 0.001 g precision. Since the specific mass of the test-food is known, weight was converted into volume using the Rosim-Rammler equation on Statistical Package for the Social Sciences version 18.0 software. The distribution of the particles by weight was described by the cumulative function of median particle size (X50), which represents a virtual sieve mesh where 50% of the particles would pass through. The higher the X50, the worse the masticatory performance.

Swallowing threshold

The individuals were handed another set of 17 Optocal cubes and instructed to chew them until they felt the urge to swallow. A trained examiner counted the number of chewing cycles and registered the total time of the cycles, which was measured with a digital stopwatch. The swallowing threshold particles were submitted to the same fragment size analysis as it was done for the masticatory performance test, described above.

Pain quantification

After the individuals chewed the Optocal cubes they were handed a visual analogic scale (VAS) for registration of the pain experienced on every experimental period. The subjects were instructed to make a mark on the 10 cm line corresponding to the pain experienced during chewing. The left limit of the scale was described as "without discomfort" and the right limit as "worst discomfort possible".

Error of method

The X50 data of 10 subjects with the same age were analyzed with the Dahlberg formula and paired t test after 2 analyses within a 7 day interval. There was no statistical difference between the evaluations ($p > 0.05$) and the reproducibility error was less than 10% for the X50 (0.5 mm).

Statistical analyses

Shapiro-Wilks test was used to verify data normality. The variables were analyzed by ANOVA for repeated measures, and by Tukey's test when they were normally distributed. The Kruskal-Wallis and Dunn's test were applied when data were not normally distributed. The SPSS software was used and the significance level was set at $p < 0.05$.

RESULTS

The results are presented in Figure 1.

Pain and Masticatory Performance

Figure 1 presents the values of pain level, median particle size chewed for 15 cycles, total chewing time and duration of each cycle.

Pain was significantly higher at T_1 when compared to T_0 and T_2 (Kruskal-Wallis + Dunn, $p < 0.05$). A significant reduction in masticatory performance also occurred in T_1 in comparison to T_0 and T_2 (Kruskal-Wallis and Dunn, $p < 0.05$). However, masticatory performance levels did not show statistical significant difference between T_0 and T_2. Total chewing time and time of each cycle were higher in T_1 than in the other experimental periods (Anova + Tukey, $p < 0.05$).

Swallowing threshold

Figure 2 demonstrates the X50 of the swallowing threshold evaluation, total chewing time, time for each cycle, and number of cycles until deglutition. The median particle size did not show statistical difference between the timepoints. Total chewing time and time for each cycle were increased in T_1 when compared to T_0 but without statistical significance. There was a statistically significant reduction when T_2 was compared to T_1 (Anova + Tukey, $p < 0.05$). Time taken for each cycle was similar in all 3 timepoints and although there was an apparent raise in T_1 it did not reach statistical significance (Kruskal-Wallis, $p = 0.092$).

DISCUSSION

This study evaluated pain, masticatory performance and swallowing threshold in patients undergoing orthodontic treatment with fixed appliances. Although the literature presents some studies on the possible functional impacts of braces,[12,13] no quantitative tool was used for objective evaluation of mastication in these studies.

Objective evaluation of masticatory function is essential in clinical trials, since patients tend to overestimate their chewing ability when evaluated only by subjective methods (e.g. questionnaires). Many patients with compromised dentition or dentures think they have a good chewing ability, even when objective tests show values much lower than in subjects with natural dentition.[7,14]

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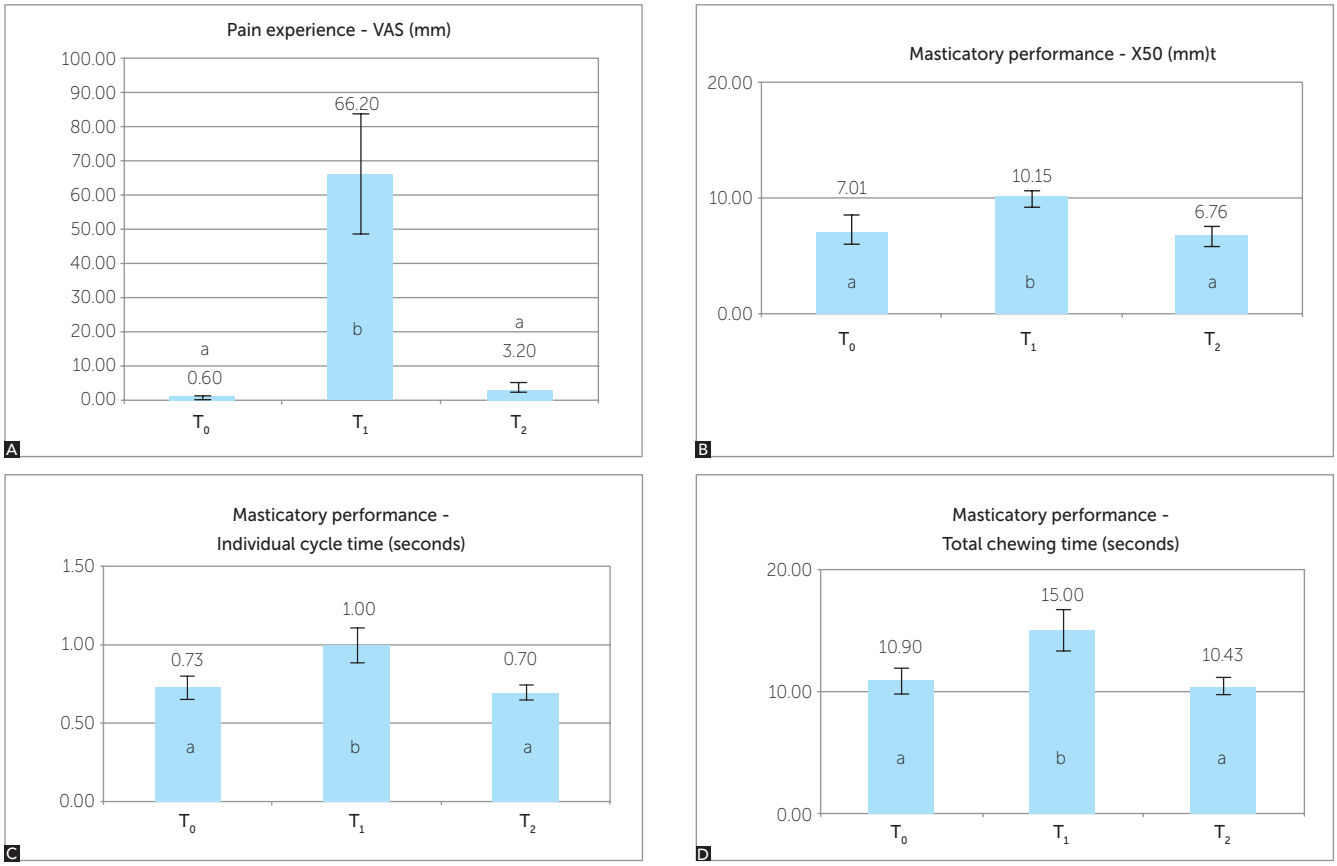


Figure 1 - Masticatory Performance Results. **A**) Pain experience expressed by VAS; **B**) X50 of the particles; **C**) Total chewing time for the 15 cycles; **D**) Individual cycle time. T_0- Before orthodontic appliance activation; T_1- 24 hours after activation; T_2- 30 days after activation. Different letters = statistical significance (Kruskal-Wallis / Dunn or ANOVA / Tukey, p <0.05).

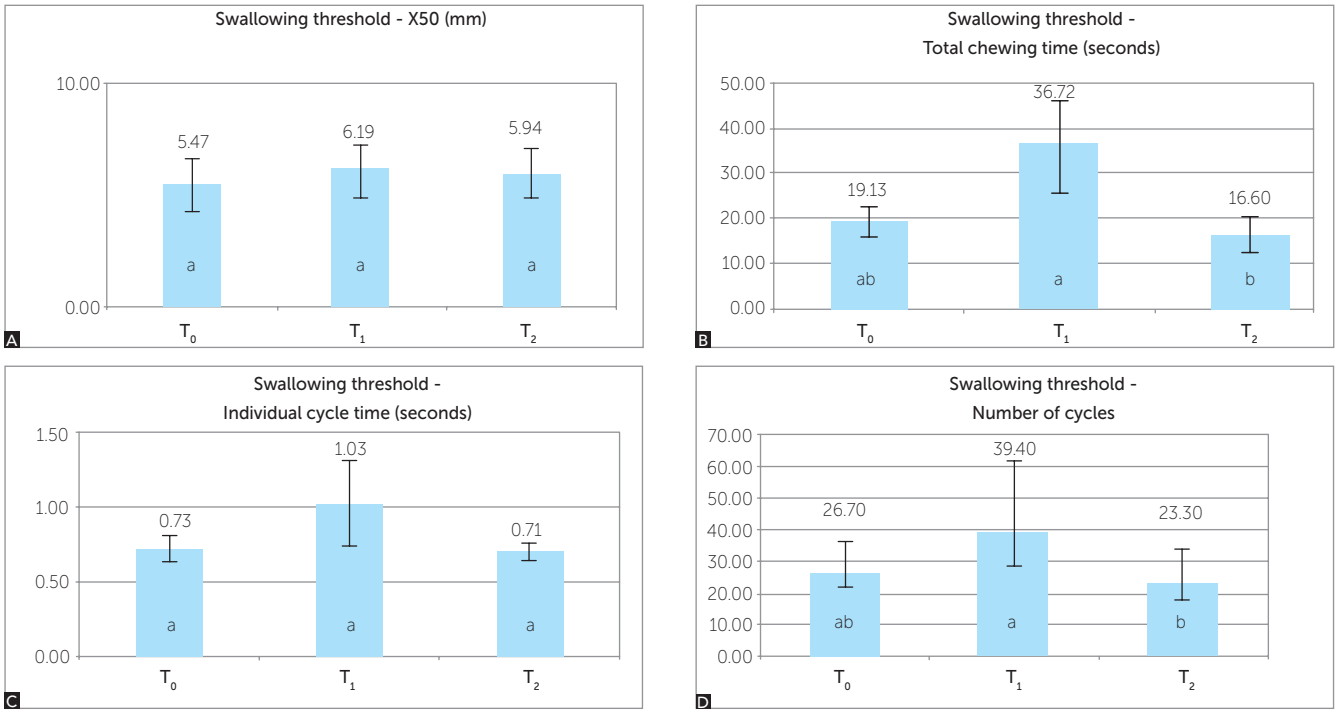


Figure 2 - Swallowing Threshold Results. **A**) X50 of the particles; **B**) Total chewing time until urge of swallowing; **C**) Individual cycle time; **D**) Number of cycles until swallowing. T_0- Before orthodontic appliance activation; T_1- 24 hours after activation; T_2- 30 days after activation. Different letters = statistical significance (Kruskal-Wallis / Dunn or ANOVA / Tukey, p <0.05).

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The present study demonstrated that orthodontic patients have low masticatory performance when measured one day after installation and activation of orthodontic appliances. This period represents the peak time of orthodontic pain, which tends to decrease significantly 3 days after insertion of archwires.[2,3,15,16] Erdinç and Dinçer[17] reported the onset of pain as occurring two hours after activation of the device, with a peak within the first 24 hours, in which the recorded average VAS was 48 mm for the group that received a nickel-titanium alloy archwire of 0.016-in section and 49 mm for the group that received a 014-in NiTi alloy archwire. Tortamano et al[18] demonstrated an average registration of 7.25 and 8.25 on a visual scale on the first day after the installation of 0.014-in individualized stainless steel archwires. However, the authors did not use a VAS, but a graduated scale of 1 to 10, in which the subjects had to choose a specific score, which may have resulted in higher average scores. Firestone, Scheurer and Bürgin[19] found an average of 27.5 mm VAS scores for pain caused after the first archwire was installed. It lasted for 7 days with a maximum record of 49.1 mm. In Ong, Ho and Miles study,[16] the peak of reported pain was reached within 24 hours. The work of Fernandes, Ogaard and Skoglund,[20] carried out with subjects from 9 to 16 years old, registered pain experience hourly for the first 11 hours and then on a daily basis for 7 days. The authors found an average of 36 and 37.2 mm VAS scores 24 hours after installation of the first archwire (0.014-in NiTi or 0.014-in Sentalloy). These studies were the basis of our choice of evaluating pain and masticatory performance after 24 hours.

Most studies indicate that there are no gender, age or initial crowding-related differences for pain after orthodontic appliance activation.[2,15,17,21] Firestone, Scheurer and Bürgin[19] did not find gender-related differences for perceived pain. Additionally, Ong, Ho and Miles[16] did not find any relationship between pain and age, gender or initial crowding. The findings of Scott et al[22] demonstrated no correlation between pain and gender or age, either. Therefore, our data was group regardless of gender, age, malocclusion or initial crowding differences. Our results are in agreement with studies that assessed pain associated with braces, and the pain levels reported in the present study (66.2 ± 34.5 mm in T_1) are very similar to those found by Polat, Karaman and Durmus[3] (59.4 ± 31.2 mm), which also recorded the experience of pain by VAS in patients during mastication.

Pain is often underestimated by orthodontists[23] and few studies have assessed the functional impacts of fixed orthodontic appliances.[12,17,24] Pain is often considered the worst aspect of orthodontic treatment, and is also one of the main reasons why patients drop out of treatment.[1,25,26] Some patients report, for example, that the incidence and severity of orthodontic pain is greater than pain caused by tooth extraction.[2] Researchers attribute pain to the hyperalgesia of the periodontal ligament (PDL) caused by induced tooth movement, which is defined as a painful sensation greater than what is expected to a noxious stimulus and felt over a larger area.[27] Orthodontic tooth pressure induces the release of chemical mediators such as histamine, bradykinin, serotonin and prostaglandins, which are capable of activating or sensitizing nociceptors in the PDL.[1,4] In addition to hyperalgesia, orthodontic pain can also be spontaneous or related to non-painful stimuli such as mechanical stimulation of the periodontium during mastication. The pain reported by stimuli that are usually non-painful is called allodynia,[27] and this was clearly observed in our study, since the pain levels were registered right after the masticatory performance and swallowing threshold tests and, after 24 hours, there was significant pain, which is not expected in normal masticatory function. These results are in accordance with those reported by Erdinç and Dinçer,[17] in which approximately 50% of their patients had problems with their daily activities on days 1 and 2 after orthodontic appliance activation and that the discomfort decreased significantly by the third day. In this same study, however, only subjective evaluations were used. In our study, the results of objective evaluation of masticatory function after 24 hours demonstrated that patients presented difficulties in grinding the test food during the masticatory performance test. This can be seen not only by the significant increase in median size of the crushed particles (X50), but also by the increase in the total chewing time and in the time of each cycle during the test.

With regard to the swallowing threshold, there was an increasing trend in time of each cycle and the number of cycles, although not statistically significant. The X50 of the particles right before swallowing was also not increased significantly within 24 hours, indicating that orthodontic patients ingest particles of similar size

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to that observed prior to the installation of the appliances (T_0). These results suggest that the chewing difficulty presented within 24 hours may have been partially balanced by an upward trend in the number of chewing cycles and time. Other ways to compensate the chewing difficulty during the peak of orthodontic pain may also have been employed, such as changes in the dynamics of jaw movements and bite force, but these variables were not evaluated in this study. Another limitation of our study is that only one test food was evaluated. This test food was chosen because it is less consistent in relation to Optosil® or Cuttersil®,[11] and patients in pain usually avoid harder foods. If we had chosen a harder test-food maybe the results would have pointed towards a more significant difference.

The consequences of inefficient chewing for general health have not been fully elucidated. The particle size ingested, which is determined by the performance of the chewing process, may influence gastric emptying. Some studies suggest that higher masticatory efficiency accelerates gastric emptying,[28,29] although this issue remains controversial. Sierpinska et al[10] found more severe chronic inflammatory changes and infection by Helicobacter pylori in the gastric mucosa in patients with dyspepsia and impaired mastication. If indeed there is a relation of cause and effect between masticatory efficiency and gastric pathologies, orthodontic therapy should not be considered as a potential cause of damage to the patient, since the present results demonstrate that although there is a reduction in masticatory performance within 24 hours, there was no difference in the size of 50X on the verge of swallowing. These findings indicate that orthodontic patients may compensate the functional limitation induced by pain with a more careful mastication until deglutition. To Fontijn-Tekamp et al,[30] individuals with poor masticatory performance tend to swallow larger particles, this observation being similar to that found by English, Buschang and Throckmorton.[13] In the first article cited,[30] adults with good oral health and varied occlusal conditions were evaluated, while the second[13] evaluated individuals with Class I, II and III malocclusions and normal occlusion, but with no braces installed. Both studies reported that individuals with poor masticatory performance do not compensate this deficiency by increasing the number of cycles until swallowing. However, these results cannot be directly compared to ours, due to the fact that these studies did not evaluate individuals with limitations caused by pain, as in our case, in which the subjects reported significant pain during the evaluation period of 24 hours after orthodontic activation. In the papers mentioned above, the performance was determined only by the dental status of individuals, whereas in our study the experience of pain significantly affected the masticatory performance of patients.

CONCLUSIONS

Patients reported a significant increase in pain during chewing 24 hours after activation of orthodontic appliances, but after 30 days there was no difference compared to baseline values.

By setting a limit of 15 chewing cycles (masticatory performance test), the median size of crushed particles was higher within 24 hours in comparison to initial and final values, which indicates a temporary deterioration in masticatory performance, since this decrease was observed only at the peak of orthodontic pain.

However, when individuals were allowed to perform the number of cycles needed until they felt comfortable to swallow (swallowing threshold test), no statistical difference between the sizes of crushed particles in any of the experimental times was found. These results demonstrate that fixed orthodontic appliances do not interfere in the size of the particles swallowed, even in the presence of orthodontic pain.

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Flexural strength of mini-implants developed for Herbst appliance skeletal anchorage. A study in Minipigs br1 cadavers

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Objective: The present study was designed to verify if mini-implant prototypes (MIP) developed for Herbst appliance anchorage are capable of withstanding orthopedic forces, and to determine whether the flexural strength of these MIP varies depending on the site of insertion (maxilla and mandible).

Methods: Thirteen MIP were inserted in three minipig cadavers (six in the maxilla and seven in the mandible). The specimens were prepared and submitted to mechanical testing. The mean and standard deviation were calculated for each region. A two-way Student's t test was used to compare the strength between the sites. A one-way Student's t test was performed to test the hypothesis. Orthopedic forces above 1.0 kgf were considered.

Results: The MIP supported flexural strength higher than 1.0 kgf (13.8 ± 2.3 Kg, in the posterior region of the maxilla and 20.5 ± 5.2 Kg in the anterior region of the mandible) with a significantly lower flexural strength in the anterior region of the mandible ($P < 0.05$).

Conclusion: The MIP are capable of withstanding orthopedic forces, and are more resistant in the anterior region of the mandible than in the posterior region of the maxilla in Minipigs br1 cadavers.

Keywords: Functional appliances. Dental implants. Orthodontic appliances. Orthodontic anchorage procedures. Angle Class II malocclusion.

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» The author Klaus Barretto Lopes asserts to be the developer and patent holder of the mini-implant prototypes used in this study.

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INTRODUCTION

Implants and mini-implants have been used as orthodontic anchorages for different purposes in different locations.[1,2,3] Some researchers have suggested the use of mini-implants as orthopedic anchors in animals[4,5] and in the treatment of Class III malocclusions with retrusive maxillae in humans.[6] However, there is little information about the use of mini-implants as orthopedic anchorage in the treatment of Class II malocclusions.

The Herbst appliance has often been used in the treatment of Class II malocclusions, because of its efficiency[7] and also because of positive effects in orthodontic and orthopedic correction.[8] Nevertheless, some investigators have stated that the correction of Class II malocclusion is a result of anchorage loss, and could be responsible for negative effects, such as protrusion and gingival recession,[9] on lower incisors.

Many attempts have been made to reduce the negative effects caused by the Herbst appliance on lower incisors, such as increasing the number of teeth in the mandibular anchorage, using soft-tissue anchorage, splints, and cast splints anchorage.[10,11] However, these attempts were unsuccessful.

With the intention of solving these problems, a mini-implant prototype was developed for Herbst appliance anchorage, and its flexural resistance was measured in an *in vitro* study.[12]. However, a question arose with respect to the resistance strength of this mini-implant prototype when inserted into the bone. The present study was designed to evaluate if the mini-implant prototype developed for Herbst appliance anchorage is capable of withstanding orthopedic forces in Minipigs br1, and to compare the prototype resistance between the sites of insertion.

MATERIAL AND METHODS

Thirteen mini-implants (Neodent, Curitiba, Brazil), 2 mm in diameter and 10 mm in length, with attachment to Herbst appliance telescopic tubes, were inserted in three Minipigs br1[13,14] (15-month old) after they had been euthanized.

A calculation of the sample size[15] was carried out by means of two pilot studies, one for the posterior region of the maxilla and another for the anterior region of the mandible of one minipig.

Based on the performance of the specimens on the graph, the sample size was calculated with the values obtained with a dislocation of 1.2 mm, because after this point the strength values increased abruptly, indicating the resistance of the metal block.

Afterwards, the following statistical formula was used:

$$n = \frac{(Z \times Cv)^2}{Er^2}$$

Where n = number of specimens, Z = Standard deviation from normal distribution, Cv = Coefficient of variation, and Er = Relative error.

After sample size calculation, the number of specimens needed for the final study was 6 in the maxilla and 7 in the mandible.

In order to test sample normality, the Kolmogorov-Smirnov test was carried out. To test the hypothesis, a one-way Student's t test was performed with Minitab 15 (State College, PA, USA). Orthopedic forces above 1 Kgf were considered.[16,17]

Thereafter, the hypotheses of withstanding orthopedic forces were defined (H0: $\mu = 1.0$ and H1: $\mu > 1.0$).

The criterion to reject the null hypothesis was:

$t_{cal} > t_{\alpha}, n-1$,

where $\alpha = 0.05$ or calculated:

$t >$ t from t table.

To compare the flexural strength between the posterior region of the maxilla and the anterior region of the mandible, a two-way Student's t test was calculated using Minitab 15.

Experiment

The animals were euthanized before the experiment and frozen at a temperature of - 20°C.

Two minipigs received four mini-implants (two in each maxilla and two in each mandible), and one minipig received five mini-implants (two in the maxilla and three in the mandible).

Six specimens with the new mini-implant were obtained from the posterior region of the maxilla, and seven specimens were obtained from the anterior region of the mandible, which were the possible places where the mini-implants could be used to anchor the Herbst appliance.

After that, the straight telescopic tube was placed in the head of the mini-implant with a suitable screw (Fig 1).

To create a guide for the mini-implant, a drill with torque control with a 1.3 mm diameter bur (Neodent, Curitiba, Brazil) was used. The insertion sites were in

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the posterior region of the maxilla, between the roots of the upper first molar and the anterior region of the mandible, between the roots of the second premolar and the roots of the third premolar.

To insert the mini-implant, a torque key with a torque meter calibrated at a measure not greater than 30 Kgf.cm was used. When the insertion was completed, new radiographs were taken to check the final positioning of the mini-implants.

To prepare the specimens, the maxilla and the mandible were sectioned into small pieces, using an electric cutting machine. Metal blocks were used to protect the specimens during the experiment. Afterwards, an acrylic resin was used to fix the bone fragments with the mini-implants (Fig 2).

The specimens were placed in an Instron 4400R test machine (Instron, Norwood, MO, USA), with the metal block in the lower part and the telescopic tube in the upper part (Fig 3).

The specimens were submitted to a single cantilever flexure test. Traction was applied at 0.5 mm per minute until 1.5 mm of dislocation was obtained. This value was based on a pilot study carried out by Brettin et al.[18] The values were recorded, and a graph of strength x dislocation was constructed.

RESULTS

Single cantilever flexure tests were successfully carried out on 13 specimens. The graphs illustrate the performance of the specimens during the tests in the maxilla and the mandible (Figs 4 and 5). The mini-implant prototypes showed a flexural strength of 13.86 ± 2.30 Kgf for the posterior region of the maxilla, and 20.5 ± 5.20 Kgf for the anterior region of the mandible. The normality of the two samples was confirmed with the Kolmogorov-Smirnov test.

For the hypothesis test, the calculated t was 13.71 ($P < 0.001$) for the posterior region of the maxilla. The critical t obtained from the table was 2.015. The criterion used to reject the null hypothesis revealed that:

$t_{cal} > t_{\alpha}, n-1$, where $\alpha = 0.05 \rightarrow 13.71 > 2.015$

Therefore, the value calculated for t for the posterior region of the maxilla is outside the region of H_0 acceptance. The null hypothesis was rejected, and the hypothesis that mini-implants cannot withstand orthopedic forces could not be confirmed for the posterior region of the maxilla.

Using the same criterion for the anterior region of the mandible, the calculated t was 9.94 ($P < 0.001$). The critical t obtained from the table was 1.943.

The criterion used to reject the null hypothesis revealed that:

$t_{cal} > t_{\alpha}, n-1$, where $\alpha = 0.05 \rightarrow 9.94 > 1.943$

Similarly to the maxilla, the value calculated for t is outside the region of H_0 acceptance. The null hypothesis was rejected, and the hypothesis that mini-implants cannot withstand orthopedic forces could not be confirmed for the anterior region of the mandible.

A statistically significant difference was found in the flexural strength between the posterior region of the maxilla and the anterior region of the mandible ($P = 0.015$): the anterior region of the mandible was significantly more resistant.

DISCUSSION

One of the purposes of this study was to quantify the flexural resistance of the mini-implant prototypes when inserted in the posterior region of the

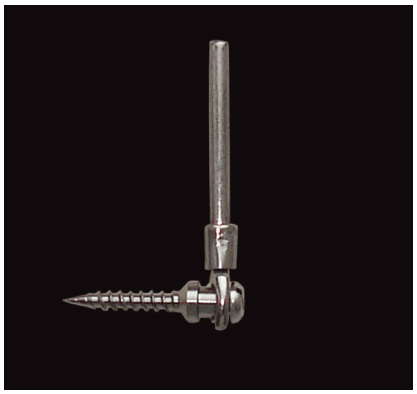


Figure 1 - Straight telescopic tube placed in the head of the mini-implant with a suitable screw.

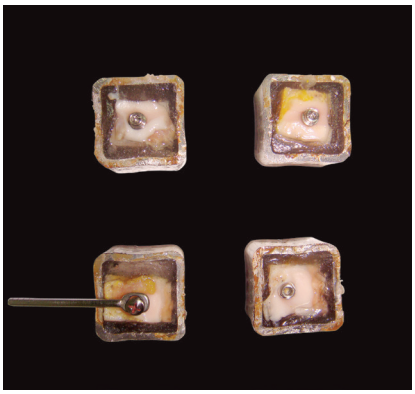


Figure 2 - Bone fragments with mini-implants inserted which were included in the metal block.

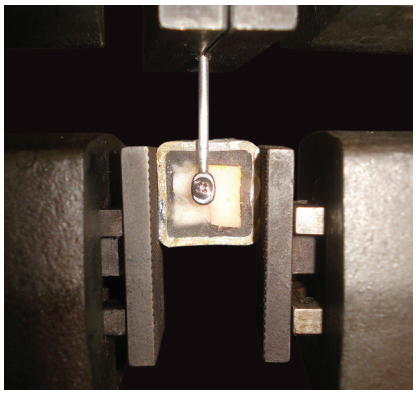


Figure 3 - Specimen ready for flexure test.

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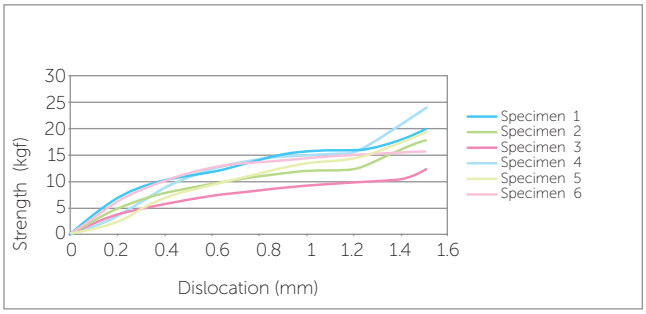


Figure 4 - Graph of strength x dislocation of six specimens tested in the posterior region of the maxilla.

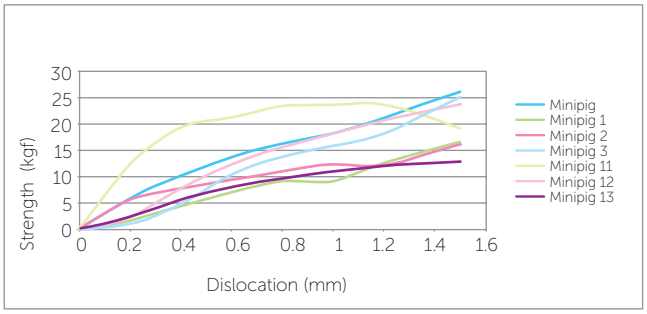


Figure 5 - Graph of strength x dislocation of the seven specimens tested in the anterior region of the mandible.

maxilla and the anterior region of the mandible. Although studies involving extrapolations from animals to humans should be viewed with caution, the authors' intention was to assess the strength that the mini-implant prototypes could withstand in specific regions in a Minipig br1. The mini-implant prototype showed a flexural strength of 13.86 ± 23.0 Kgf for the posterior region of the maxilla, and 20.55 ± 5.20 Kgf for the anterior region of the mandible. Another purpose of this study was to test the hypothesis that mini-implant prototypes are not capable of withstanding orthopedic forces. The hypothesis was rejected.

Miyawaki et al[3] reported that the success rate of mini-implants with a 1.0-mm diameter was significantly lower than that of other mini-implants with 1.5-mm or 2.3-mm diameters. This author suggested the use of mini-implants with a 1.5-mm diameter for patients with average-to-low mandibular plane angle, and a 2.3-mm diameter for patients with a high mandibular plane angle (i.e., with a thin cortical bone). Miyawaki et al[3] did not find a significant association between the success rate and the mini-implant length. However, Brettin et al[18] concluded that bicortical mini-implants provide superior anchorage resistance, reduced cortical bone stress, and superior stability when compared with monocortical mini-implants. Also, according to Barros et al[19] increases in mini-implant diameters significantly influenced the increases in placement torque and fracture torque on quantities that progressively reduced the fracture risk. Therefore, in order to increase the resistance of the mini-implant prototype, the diameter was increased to 2.0 mm and the length to 10 mm, so as to achieve bicortical anchorage.

It could be argued that the 2.0-mm diameter mini-implant is too large for the inter-radicular space. However, Poggio et al.[20] showed that, in humans, this size is compatible with the inter-radicular distance between the upper first molars and second premolars and between the lower cuspids and the first premolars (3 mm when the distance from the alveolar crest is 8 mm). This is the location suggested for the insertion of the mini-implant prototypes for the Herbst appliance anchorage.

Two pilot studies were performed before the experiment to test the researchers' abilities and to calculate the sample size.[15] The number of specimens was calculated in order to obtain scientific validation with the fewest possible specimens and animals.

In the present study, the mini-implant prototypes were inserted after the animals had been euthanized. Huja et al[21] explained that no healing period or adaptive response could occur, and resistance strength was an indication of primary stability. Therefore, the values found in the present study are similar to the experiments of immediate loading after placement. Some studies have evaluated bone contact according to the healing period, recommending immediate loading after placement.[1,22,23]

Storage conditions of the specimens used in the study have been associated with differences in pull-out strengths during mechanical traction testing. Simonian et al[24] found lower pull-out strengths in frozen specimens. However, Roe et al[25] reported no significant difference when the test was performed no later than one week after storage at - 20° C. Therefore, to avoid any influence of storage conditions on the results, the specimens used in this study were prepared

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on the same day or on the day after insertion of mini-implants, frozen at - 20º C and tested between one and seven days after mini-implant insertion.

A single cantilever flexure test was performed instead of a shear force test and traction test, because there was a distance of 4 mm between the block base and the point of force application. In a shear force test, the point of force application should be parallel to the block base. A traction test would not reproduce the perpendicular strength received by the mini-implant when used as an anchorage for the Herbst appliance.

Brettin et al[18] also performed a cantilever flexure tests, but in human cadavers. They found lower values than those of the present study (20.55 kgf for bicortical mandibular mini-implants and 13.86 kgf for monocortical maxillary mini-implants in Minipigs, against 11.0 kgf for bicortical mandibular mini-implants and 9.0 kgf for bicortical maxillary mini-implants, 5.0 kgf for monocortical maxillary mini-implants and 7.0 kgf for monocortical mandibular mini-implants in human cadavers). This difference may be related to the larger diameter of the mini-implants used in the Minipigs (2.0 mm in the Minipigs against 1.6 mm in the human cadavers) or increased cortical bone thickness in the Minipigs.

The cantilever test is a static test. Probably, if dynamic forces had been applied to the mini-implants, different results would have been obtained. Future *in vivo* studies using the Herbst appliance anchored in bone will answer this question.

According to Huja et al[21] some possible problems were related to cantilever tests, namely: standardization, reproducibility, bone flexure and collision of the mini-implants with adjacent root of the tooth. These problems could negatively influence accuracy of results regarding the flexural strength of the mini-implants. In this research, these possible problems were avoided, because the flexural strength of the mini-implants was obtained following the experiment performed by Brettin et al[18] in which the mini-implants were tested with dislocation of 1.5 mm. Those authors performed a pilot study in cadavers in which they concluded that the mini-implants could present mobility with dislocation above 1.5 mm.

To test the hypothesis, orthopedic forces above 1.0 kgf were considered. This value is very common in Orthodontics, in clinical work and research, because of the headgear which functions with 500 g per side.[16,17] Other studies showed the use of orthopedic forces (from 500 to 800 g) on implants[4,5,6] and a few focused on the use of orthopedic forces in mini-implants, such as the study by Büchter et al[26] who found that mini-implants resisted up to 900 g without mobility.

The flexural strength differed significantly between the posterior region of the maxilla and the anterior region of the mandible. However, this result may have been influenced by the fact that the mini-implants fixed in the mandible had bicortical anchorage while those fixed in the maxilla apparently did not have this anchorage. Probably, the distance between the cortical bones in the maxilla in the posterior region was greater than 6 mm or the cortical-lingual was not accessible due to the palate being too low. Because the mini-implant was 10 mm long, the active part was only 6 mm. This suggests that in future studies the mini-implants should be constructed according to the distance between the cortical bone, as Brettin et al[18] did with human cadavers.

Other forces that could affect the resistance of the mini-implant prototypes could be those originating from muscles and soft tissues of the face, due to mandibular advancement caused by functional appliances. However, earlier studies[27,28] showed that the forces delivered to the teeth by functional appliances were of low intensity (80 and 160 gf).

The question that arises is whether to use mastication forces as a parameter rather than the orthopedic forces. According to Pancherz and Anehus-Pancherz[29], there is no contact in the posterior teeth after the installation of the Herbst appliance. The contact occurs only in the anterior teeth. This is responsible for the decrease in mastication efficiency as well as in temporal and masseter muscle activity in the first three months of treatment. After that, the authors observed an increase in the mastication forces during six months of treatment.

The forces transmitted to the teeth when using the Herbst appliance are probably the best parameter. However, it was not possible to locate studies with the data that is necessary to carry out a statistical analysis, and the force transmitted to the mini-implants in the skeletal anchorage of the Herbst appliance remains unknown.

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Thus, *in vivo* and clinical studies are necessary to assess the possibility of using the Herbst appliance skeletal anchorage in humans.

CONCLUSION

The mini-implant prototypes developed for Herbst appliance skeletal anchorage are capable of withstanding orthopedic forces in Minipigs br1 cadavers. The prototypes are more resistant in the anterior region of the mandible than in the posterior region of the maxilla.

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Treatment of dental and skeletal bimaxillary protrusion in patient with Angle Class I malocclusion

Claudio José Ramos[1]

In the orthodontic clinic, skeletal and dental bimaxillary protrusion is presented frequently as one of the factors leading patients to seek orthodontic treatment, mainly due to the esthetic involvement it has. The patient of this article illustrates this situation, being deeply uncomfortable with her esthetic appearance, due to the excessive upper incisors exposure and problems with lip sealing. This case was presented to the Brazilian Board of Orthodontics and Facial Orthopedics (BBO), as part of the requisites to become a BBO Diplomate.

Keywords: Class I malocclusion. Corrective orthodontics. Esthetics.

INTRODUCTION

Caucasian female patient, 33 years and 5 months old, with the chief complaint: "I want to correct my teeth, because they are sticking out, and also improve my esthetics". The clinical exam showed the need of closing preexisting spaces, due to dental extractions, and reducing bimaxillary and dental protrusion. Anamnesis showed good general health.

DIAGNOSIS

The patient's facial aspect, in frontal view, did not present visible asymmetry, but absence of passive lip sealing. From the lateral view, the patient presented a convex profile, normal nasolabial angle, lack of lip sealing at rest, and increased lower anterior facial height (Fig 1). The patient presented a Class I molar relationship and 5 mm overjet; slight upper and

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* Clinical case approved by the Brazilian Board of Orthodontics.

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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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lower crowding; moderate Curve of Spee; absence of teeth #36 and #37; posterior cross bite on the right side, with buccal cross bite between teeth #15 and #45; lower midline deviated 1 mm to the left; and upper and lower incisors with incisal wear (Fig 2). The periapical and panoramic radiographs demonstrated root shortening of the upper right central incisor, absence of teeth #36 and #47, lower molar mesialization and lack of parallelism between roots (Figs 3 and 4).

In skeletal terms, according to the lateral cephalometric radiograph and respective tracing (Fig 5), it was observed that the patient presented unbalanced skeletal bases, characterized by angles SNA = 90°, SNB = 83° and ANB = 7°, with a dolichofacial pattern, and presenting protruded upper incisors, with slight lingual tipping, and protruded lower incisors with buccal tipping.[1] The functional analysis of mandibular movements revealed absence of anterior guides.



Figure 1 - Initial facial and intraoral photographs.

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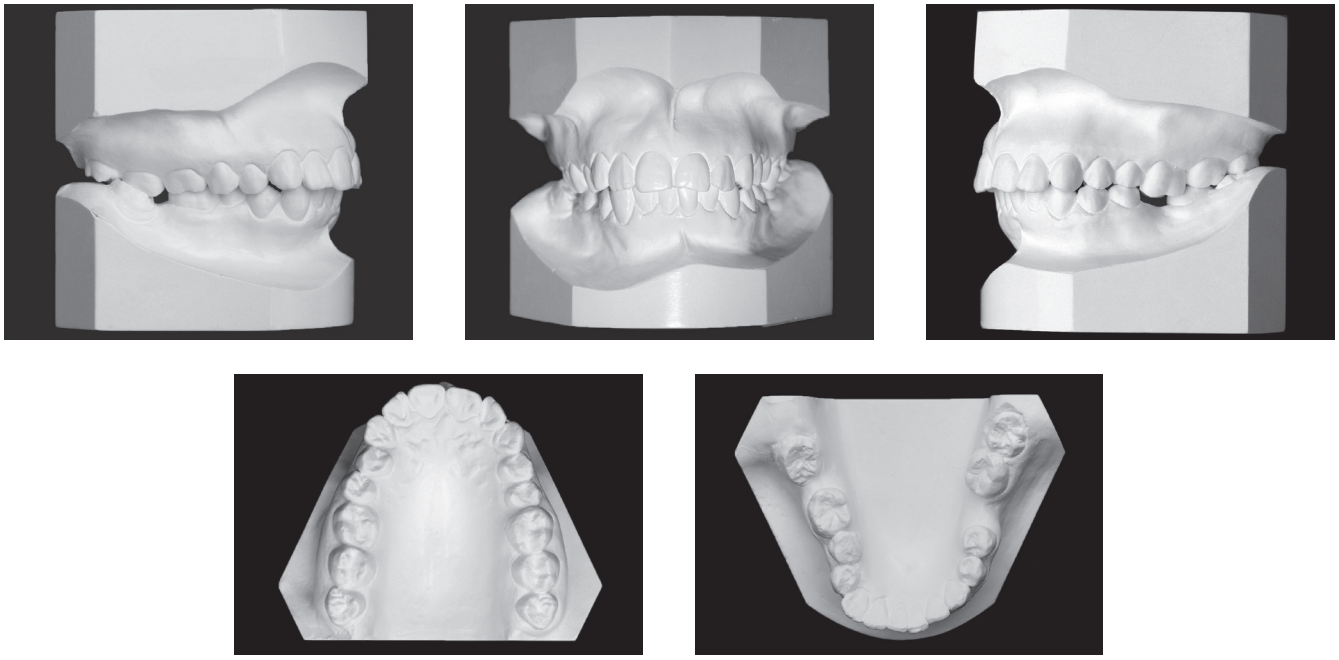


Figure 2 - Initial casts.

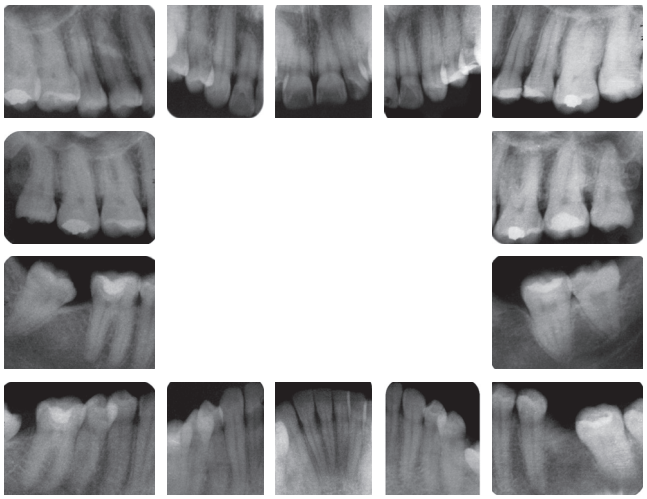


Figure 3 - Initial periapical radiographs.



Figure 4 - Initial panoramic radiographs.

TREATMENT PLAN

Due to compromised facial esthetics and dental and skeletal bimaxillary protrusion, the treatment plan had the following objectives: Maintain canine occlusion; align and level the teeth; eliminate posterior cross bites; reduce overbite and overjet; eliminate crowding on both arches; level the Curve of Spee, close the spaces due to extraction of teeth #36 and #47, and also achieve lower molar root parallelism.

For this purpose, extractions of the first upper and right lower premolars were necessary, besides the retraction of upper and lower anterior teeth, to reduce bimaxillary protrusion and correct the lower midline. All this very carefully, in order to avoid root shortening of tooth #11.

The treatment also aimed at obtaining lateral and protrusion guides, and reduction of facial convexity. The nasolabial angle would be preserved, as well as

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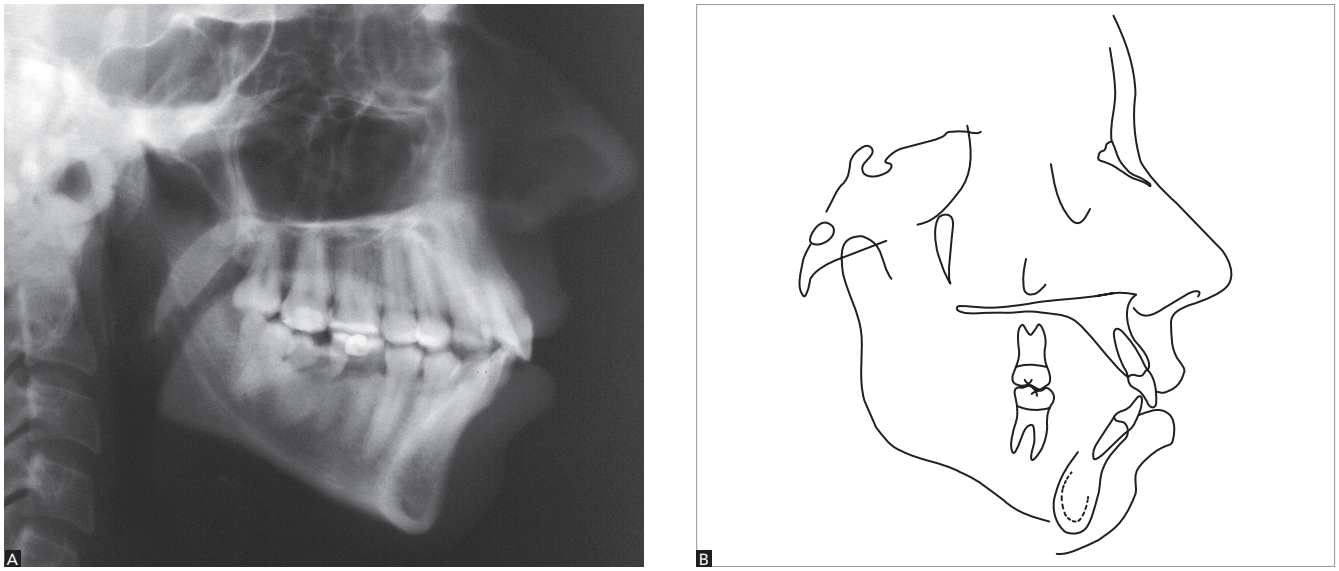


Figure 5 - Initial lateral cephalometric radiograph (A) and cephalometric tracing (B).

passive lip sealing would be expected and decrease of the lower anterior facial height, in order to reach smile harmony.

TREATMENT PROGRESS

The treatment was performed with the Straight wire technique, using metallic orthodontic brackets in both arches, according to Roth's prescription (0.022 x 0.028-in), with a removable transpalatal bar (stainless steel archwire, 0.032-in) as upper arch anchorage, and a lip bumper as lower arch anchorage. Leveling and alignment were carried with a sequence of NiTi round archwires, NiTi rectangular archwires 0.017 x 0.025-in and stainless steel rectangular archwires 0.019 x 0.025, with loops for retraction of anterior teeth and 5/16-in elastics to assist in the finishing.

Bands were placed on the first and second upper molars, as well as on the first, second and third lower molars, with a transpalatal bar on the first upper molars and lip bumper on lower molars.

The placement of the fixed orthodontic appliance was completed with the direct bonding of brackets on the remaining upper and lower teeth, except on teeth #14, #24 and #44 — which would be extracted, with the objective of eliminating crowding and allow the correction of the dental bimaxillary protrusion, by means of retracting the anterior teeth.[1,3,4] Alignment and leveling were carried with 0.012, 0.014, 0.016 and 0.018-in NiTi archwires; and 0.017 x 0.025-in NiTi rectangular, and stainless steel 0.019 x 0.025-in archwires. Then, the retraction of upper and lower anterior teeth, and the correction of the lower midline were performed. The extraction of tooth #18 was suggested because it would be without its antagonist due to the mesial movement of tooth #48. For intercuspation, 5/16-in intermaxillary elastics were used.

A stainless steel 0.028-in fixed lower retainer was bonded to teeth #33 to #45, and to teeth #35 to #37. On the upper arch, a wraparound removable plate was used.

OBTAINED RESULTS

The evaluation of the final records shows that there was 1° reduction for SNA and SNB angles, a slight decrease in the vertical direction (Table 1). The canine guidance was kept, there was overjet reduction and overbite and Curve of Spee correction. All teeth were aligned and leveled, and the posterior cross bites eliminated; the crowding

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on both arches was corrected; Curve of Spee was leveled. The spaces for teeth #36 and #47, and also the extraction spaces for teeth #14, #24 and #44 were properly closed; upper and lower anterior retraction was satisfactory.

The lower midline correction and anterior guides were obtained. However, lip sealing was not completely passive, due to the patient's vertical growth pattern. The nasolabial angle was preserved, despite the decrease of incisor protrusion, which promoted smile harmony (Figs 6 to 10). The treatment lasted 35 months.

FINAL CONSIDERATIONS

The treatment of dental skeletal bimaxillary protrusion was successful, once the main objectives proposed to the patient were achieved, resulting in good occlusion and pleasant facial esthetics (Fig 6). A good parallelism was obtained between roots, especially for lower molars. The pre-existing spaces before treatment and those caused by the extraction of teeth #14, #24 and #44 were properly closed, with upper and lower anterior retraction (Fig 7).



Figure 6 - Final facial and intraoral photographs.

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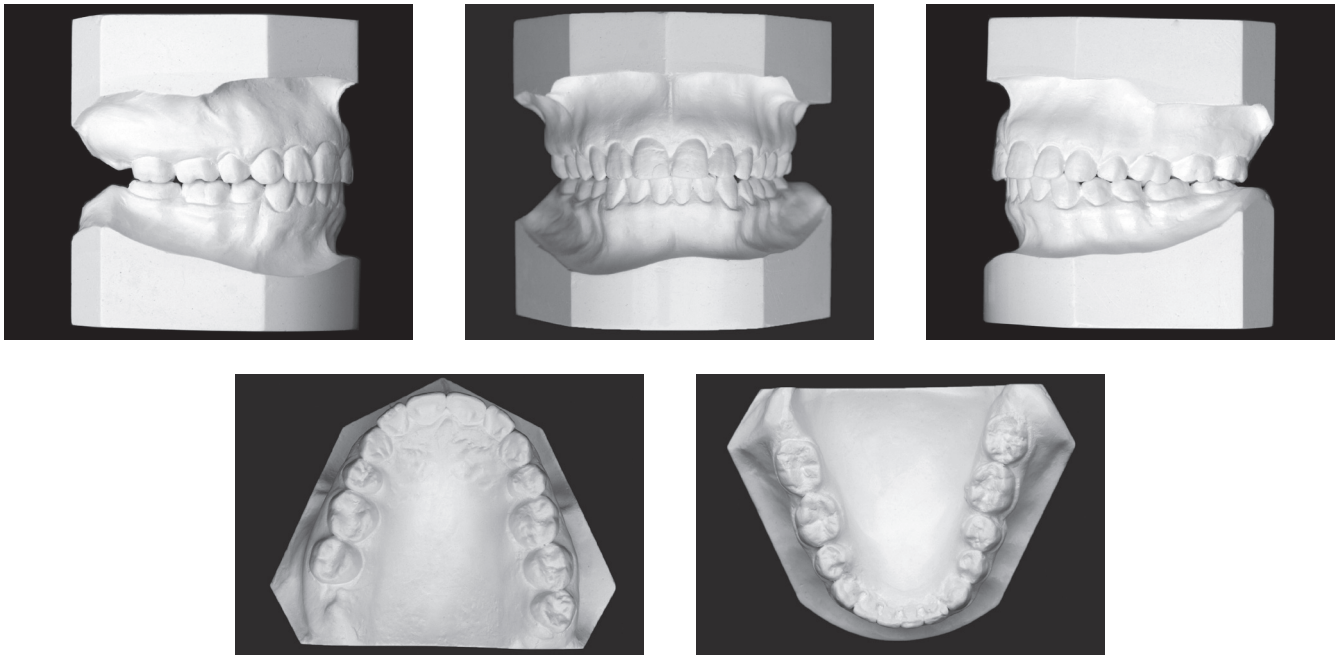


Figure 7 - Final casts.

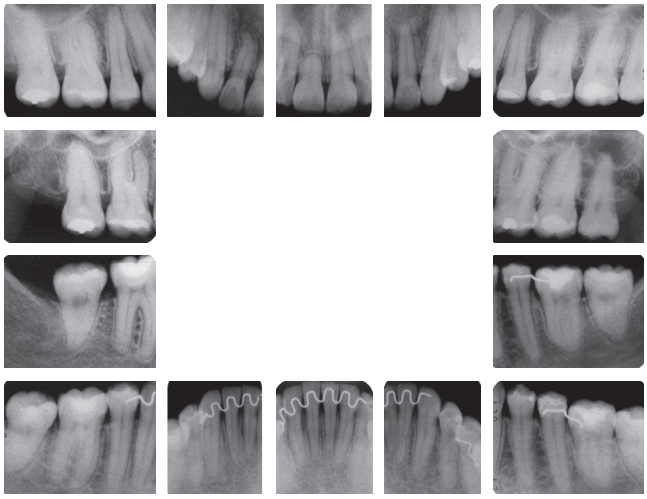


Figure 8 - Final periapical radiographs.



Figure 9 - Final panoramic radiograph.

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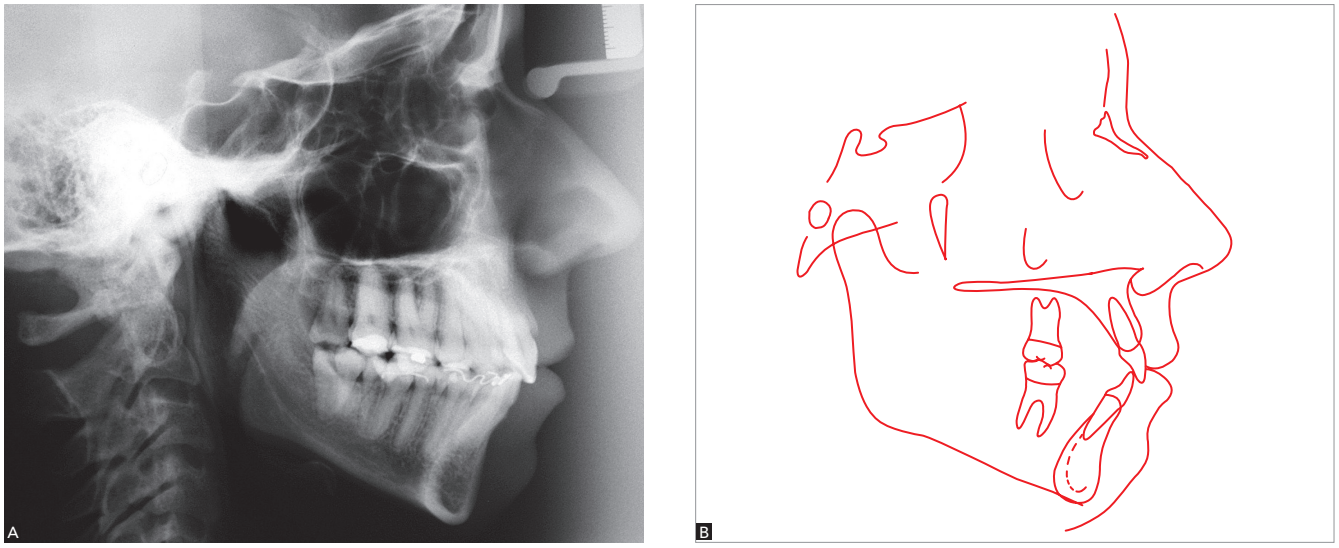


Figure 10 - Final lateral cephalometric radiograph (**A**) and cephalometric tracing (**B**).

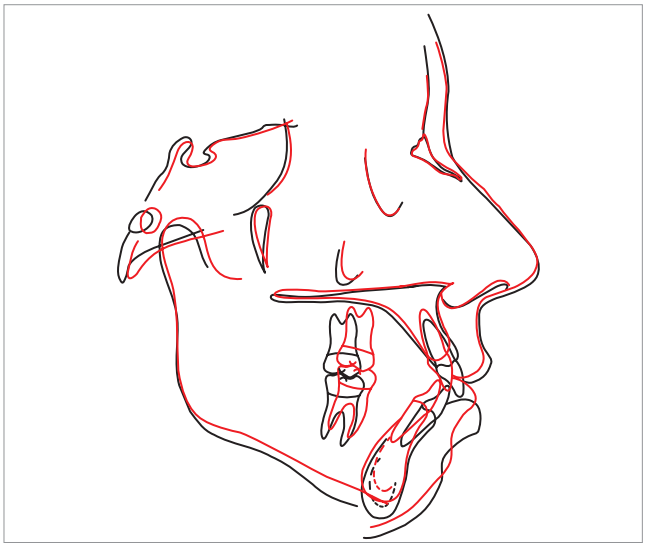


Figure 11 - Total superimposition of initial (black) and final (red) cephalometric tracings, registered on SN line.

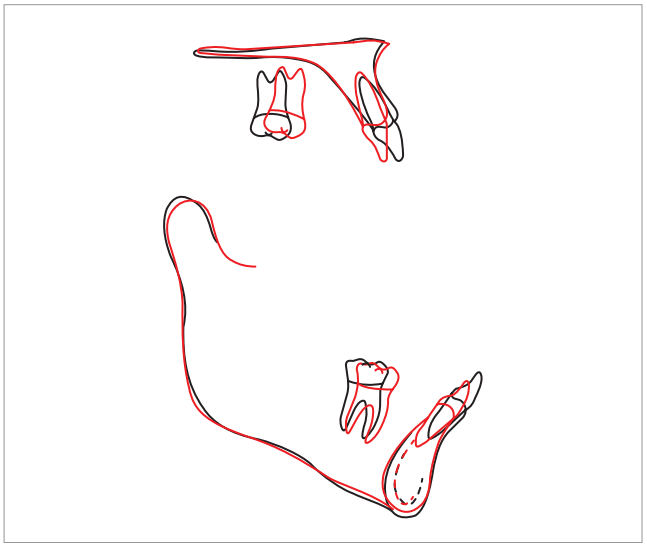


Figure 12 - Partial superimposition of the maxilla (A) and the mandible (B), of initial (black) and final (red) cephalometric tracings, evidencing tooth movements.

In facial terms, passive lip sealing, initially expected, was not completely obtained, mainly due to increased anterior facial height. Nevertheless, greater smile harmony was obtained, which fully met the patient's expectations, who always collaborated regarding oral hygiene and clinical recommendations.

The level of root resorptions was acceptable, except for the upper right central incisor, in which the root shortening increased significantly,[7,9] but without any mobility observed in regular evaluation of each treatment phase (Fig 8). The patient was pleased with the treatment result, since it improved her facial esthetics

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Table 1 - Cephalometric measures.

	Measures		Normal	A	B	A/B diff.
Skeletal pattern	SNA	(Steiner)	82°	90°	89°	1
	SNB	(Steiner)	80°	83°	82°	1
	ANB	(Steiner)	2°	7°	7°	0
	Facial angle	(Downs)	0°	15°	16°	1
	Y axis	(Downs)	59°	60°	57°	3
	Facial angle	(Downs)	87°	88°	88°	0
	SN-GoGn	(Steiner)	32°	32°	30°	2
	FMA	(Tweed)	25°	25°	24°	1
Dental pattern	IMPA	(Tweed)	90°	101°	103°	2
	1.NA (degrees)	(Steiner)	22°	21°	14°	7
	1-NA (mm)	(Steiner)	4 mm	7 mm	3 mm	4
	1.NB (degrees)	(Steiner)	25°	35°	35°	0
	1-NB (mm)	(Steiner)	4 mm	12 mm	9 mm	3
	1/1 - Interincisal angle	(Downs)	130°	117°	126°	9
	1-APo (mm)	(Ricketts)	1 mm	8 mm	4 mm	4
Profile	Upper lip – S line	(Steiner)	0 mm	2 mm	0 mm	2
	Lower lip – S line	(Steiner)	0 mm	5 mm	1 mm	4

substantially,[8] with the reduction of dental and skeletal bimaxillary protrusion.[2] After removing the appliances and placing new retainers, the patient was referred to dental whitening and composite restoration of the incisal borders of the upper anterior teeth. Thus, after the recommended procedures, an even more pleasant smile was obtained, which contributed significantly for the patient's complete satisfaction.[6]

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Reconstruction of alveolar cleft with allogenous bone graft: Clinical considerations

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Introduction: Secondary bone grafting consists in a routine procedure on the treatment of patients with alveolar cleft. Usually, it is performed by the end of the mixed dentition, when the permanent canine is erupting, with autogenous cancellous bone from the iliac crest.

Objective: The present article discusses the alternative of autogenous bone grafting with allogeneic bone, obtained from human bone bank, illustrating the result with the presentation of a clinical case of left unilateral alveolar cleft.

Keywords: Orthodontics. Cleft palate. Bone transplant.

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

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GENERAL CONSIDERATIONS ON ALVEOLAR CLEFT AND SECONDARY BONE GRAFTING

The cleft lip and alveolar ridge (pre-incisive foramen clefts) and the complete cleft lip and palate (trans-incisive foramen clefts)[19] demand surgeries, at strategic time, for reconstitution of the morphological defect. The primary plastic surgeries, cheiloplasty and palatoplasty, reconstruct the cleft lip and palate in soft tissue during childhood, from 3 and 12 months of age, respectively. The alveolar bone disruption, exactly at the height of the upper lateral incisor, persists after primary plastic surgeries, maintaining the discontinuity of the alveolar arch and upper arch. The normalization of the alveolar bone defect, persistent after primary plastic surgeries, is achieved with marrow-cancellous bone autogenous grafting from the iliac crest.[1,2] This procedure is performed during the mixed dentition, more precisely near the period of eruption of the permanent canine adjacent to the cleft, between 9 and 12 years of age — therefore, it is designated as secondary bone grafting.[20] Thus, the secondary alveolar bone grafting represents fundamental part in the process of rehabilitation of patients with cleft involving the alveolar ridge. Figure 1 illustrates the facial and occlusal condition of the patient subjected to primary plastic surgeries and to secondary bone grafting, within the conventional rehabilitation protocol. The advantages of secondary bone grafting are related to the elimination of alveolar defect without negative interference on the maxillary growth potential.[18] The grafted bone becomes alveolar bone (Fig 2), continuing the alveolar ridge and providing support to the nasal base. The newly formed alveolar bone allows spontaneous[7,12] or forced[21] tooth movement, and offers better periodontal conditions for the teeth adjacent to the cleft.[1,2,25] Eliminating the alveolar bone defect, it is possible to finish the rehabilitation procedure without prosthesis in the area of the involved lateral incisor, and with the continuous alveolar arch, without interruption (Figs 1 and 2). Ultimately, the neoformed bone allows implant installation with prosthetic purpose. The success index of secondary bone grafting is clinically and radiographically[25,28] measured, as exemplified on Figures 1 and 2. From the radiographic point of view, the periapical radiographs of the graft area and the occlusal radiograph of the maxilla allows evaluating the level of neoformed bone in the cleft region. However, the most accurate bone diagnosis is performed with CT, for it allows a three-dimensional evaluation and the depth reading of the neoformed bone.[10] Several radiographic researches have proved the success of secondary bone grafting,[1,2,5,12,17,25,28,27] making it definitive in the therapeutic process of clefts involving alveolar ridge.

CONSIDERATIONS ON GRAFTING WITH AUTOGENOUS BONE

The bone to be grafted in the alveolar cleft region can be autogenous, allogeneic or synthetic. The autogenous secondary alveolar bone grafting technique is the most widely used on the rehabilitation of cleft patients and was technically detailed by Boyne,[3] in 1974, and by Boyne and Sands,[4] in 1976.

In a short period, about 3 months, the grafted autogenous bone totally reintegrates to the area, the radiographic distinction between the cleft limit and the neoformed bone is difficult. The osteoblasts survive, functionally, in an autogenous graft, ensuring bone vitality.

The autogenous bone graft from the iliac crest has been the favorite by rehabilitators, worldwide, including at the Hospital of Rehabilitation of Craniofacial Anomalies of USP (HRAC-USP, in Bauru/SP). The iliac crest bone, enough to completely fill the alveolar defect, is medullary, to favor and accelerate the transformation of the grafted bone. Other donor sites, such as tibia,[13] rib,[29] skullcap,[6] retromolar region[16] and mandibular symphysis,[14] have been used. The iliac bone is the most used because the iliac crest features a large amount of medullary bone, with greater amount of osteoinductive cells.[24] The disadvantages comprise the morbidity resultant from obtainment of graft and the necessity of a medical professional to obtain the graft, often an Orthopedist.

Although the height of the bony septum formed in the cleft region is similar in the bones obtained from the iliac crest and mandibular symphysis,[22] the mandibular symphysis can only be used in narrow clefts, which do not require large amount of tissue to be filled.

CONSIDERATIONS ON ALLOGENEIC BONE OBTAINED FROM BONE BANK

Using allogeneic bone (allografts),[8] eliminates the disadvantages from using autogenous bone, obtaining bone tissue in adequate amount, without the necessity

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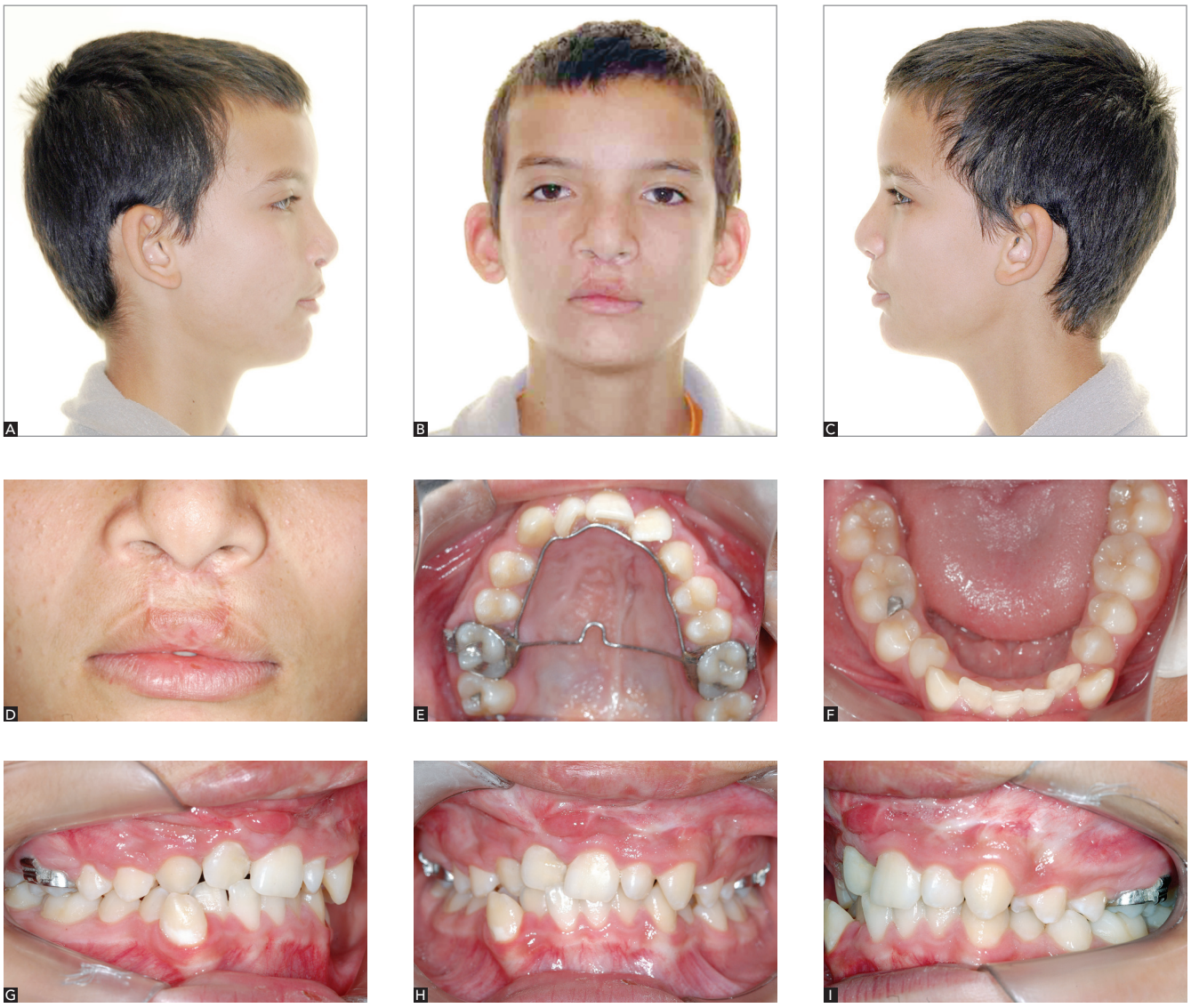


Figure 1 - **A)** Right lateral facial photograph. **B**) Frontal facial photograph of patient with cleft involving the alveolar ridge on the right. The secondary bone grafting procedure continues the alveolar ridge, creating periodontal conditions favorable to the movement of teeth adjacent to the congenital bone defect. **C**) Left lateral facial photograph. **D**) Facial photograph with zoom on the cleft region. **E**) Upper occlusal photograph: alveolar cleft (unilateral pre-incisive foramen), segmenting the alveolar ridge on the left upper lateral incisor region — beginning of mixed dentition. **F**) Lower occlusal photograph. **G**) Right lateral intraoral photograph. **H**) Frontal intraoral photograph. **I**) Left lateral intraoral photograph.

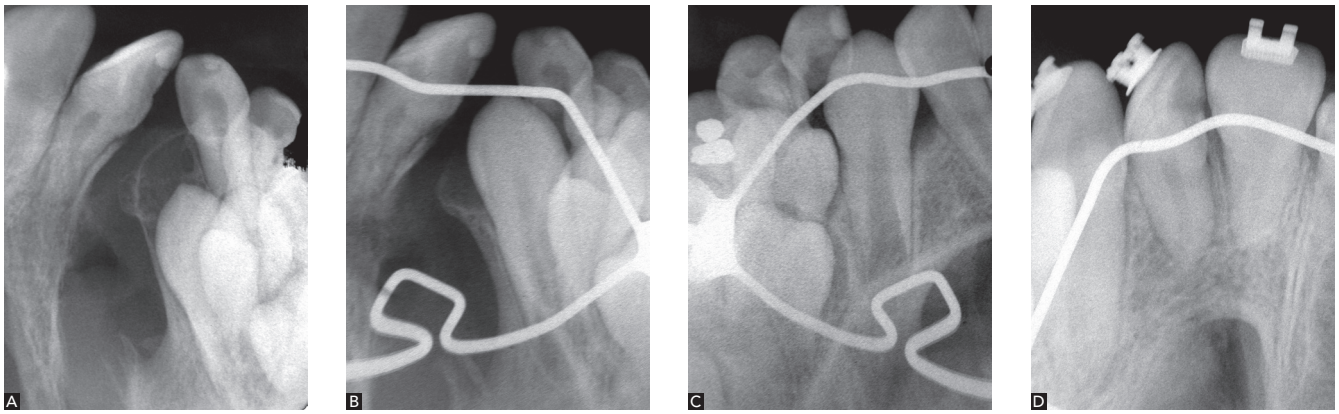


Figure 2 - **A)** The longitudinal radiographic evaluation by means of periapical radiographs of the cleft area shows the incorporation of the autogenous bone grafted in the subjacent bone tissue. **B**) Permanent canine eruption in the graft area. **C**) Canine eruption of in the graft area. **D**) Orthodontic movement in the grafted area.

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of a donor site and a medical professional to obtain the bone to be grafted. The allografts present osteoconductive and osteoinductive properties. The osteoconductive properties are assigned to the mineralized collagen structure, forming a scaffold that allows bone deposition. The osteoinductive properties are assigned to the presence of BMPs (bone morphogenetic proteins), which are released by osteoclastic activity, biostimulation to the graft incorporation.[15,39,31] With the development of tissue engineering, fundamental principles were established for the regeneration of certain tissues.[23] Among them, the use of extracellular matrix similar to the tissue to be regenerated, once its structure and molecular composition exert chemical and mechanical properties required for differentiation of parenchymal cells and for the tissues physiological demand.[15] Certain molecules that compose the matrix act as regulators of the cell function – which, in the case of bone tissue, are the BMPs. These are secreted by osteoblasts in case of bone deposition.[15] Such characteristics, extracellular matrix and presence of BMPs, are present in allografts. By the data collected in literature, there are no reports on reconstruction of alveolar cleft with allogeneic bone. Therefore, the objective of the present article consists in presenting, through a clinical case, the reconstruction of the alveolar cleft with allogeneic bone from bone bank.

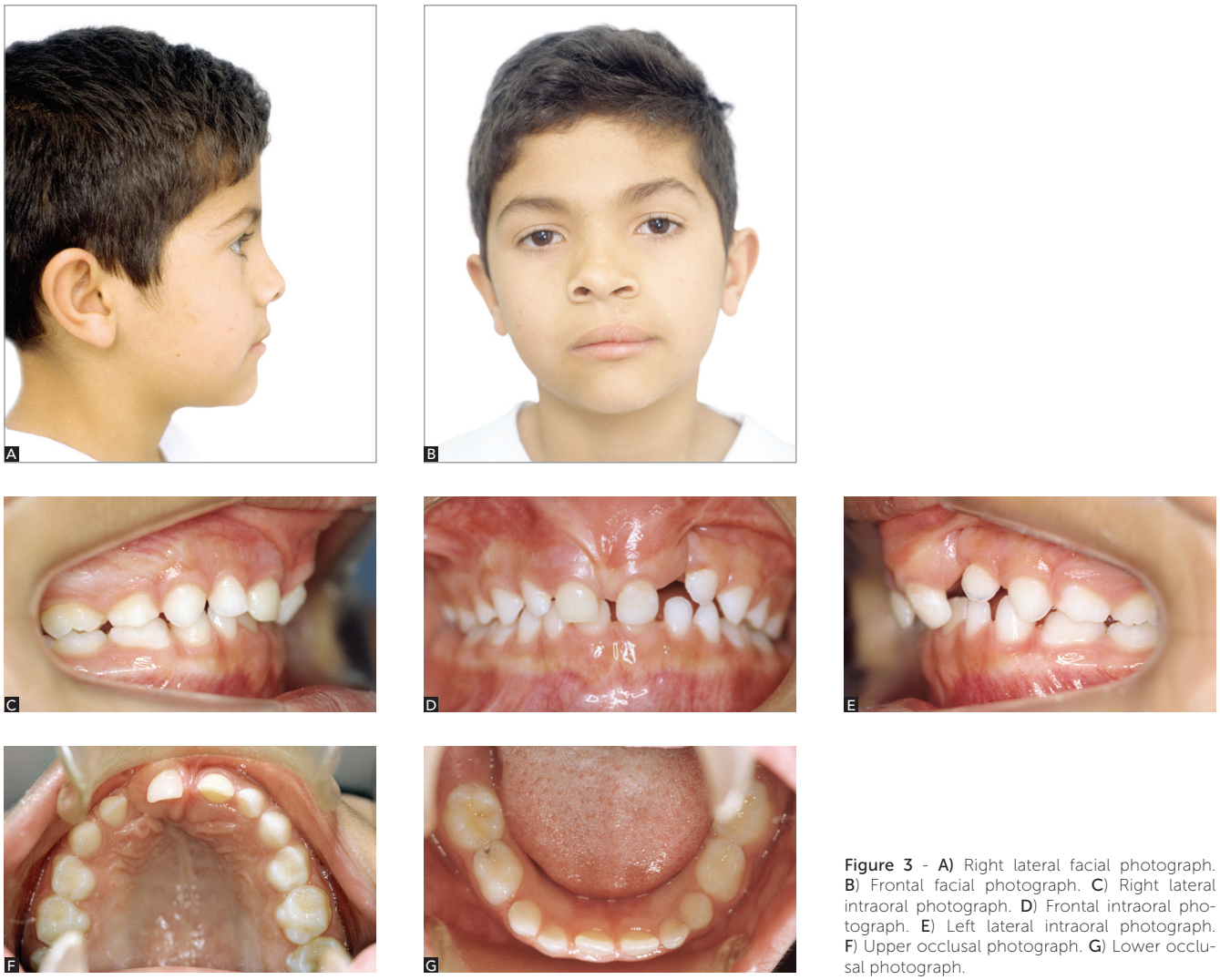


Figure 3 - **A)** Right lateral facial photograph. **B**) Frontal facial photograph. **C**) Right lateral intraoral photograph. **D**) Frontal intraoral photograph. **E**) Left lateral intraoral photograph. **F**) Upper occlusal photograph. **G**) Lower occlusal photograph.

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CLINICAL CASE DESCRIPTION

The patient, with unilateral complete cleft lip and alveolar ridge (pre-incisive foramen clefts), on the left-side, underwent primary cheiloplasty during childhood and initiated the orthodontic follow-up at the beginning of the mixed dentition (Fig 3), with alveolar bone defect typical of a unilateral complete alveolar ridge cleft (Fig 4). The treatment protocol involved the control of the occlusion development, assisting permanent teeth eruption and pre-canine behavior in the alveolar cleft site (Figs 5 and 6). The bone grafting with allogeneic bone, obtained from a bone bank, was performed when pre-canines and permanent canines were erupting (Fig 7). The grafted bone became alveolar bone, allowing the eruption of teeth adjacent to the cleft site (Fig 8). The orthodontic treatment concluded the occlusion with the left pre-canine working as a lateral incisor (Fig 9). The final radiographs (Fig 10) and 1 year after treatment (Fig 11) illustrate the good quality of the alveolar bone in the cleft site.

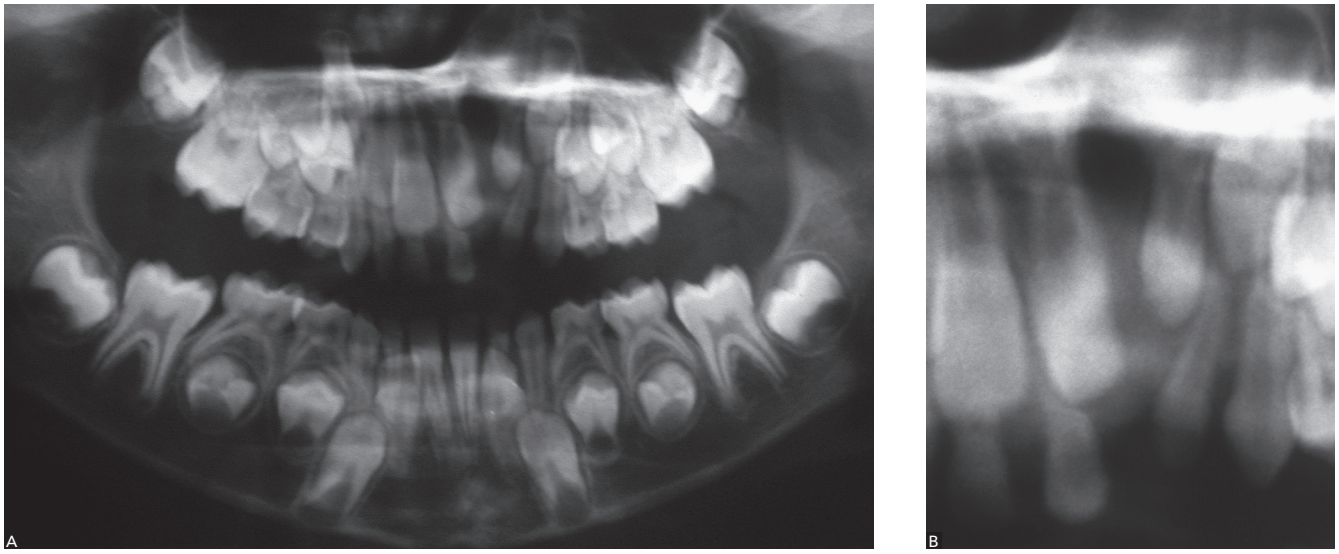


Figure 4 - **A)** The panoramic radiograph reveals the upper left alveolar bone defect with tooth agenesis # 22. In addition, the presence of a pre-canine tooth adjacent to the alveolar cleft is found. Such tooth is common in clefts that completely disrupt the alveolar ridge. **B**) The periapical radiograph of the upper anterior region reveals, more clearly, the alveolar bone defect on the upper left, along with tooth agenesis #22 and presence of pre-canine tooth adjacent to the alveolar cleft.



Figure 5 - **A)** Right lateral intraoral photograph. **B**) Frontal intraoral photograph. **C**) Left lateral intraoral photograph. Control of permanent teeth eruption, in the mixed dentition, with persistent alveolar bone defect. **D**) Upper occlusal photograph. **E**) Lower occlusal photograph.

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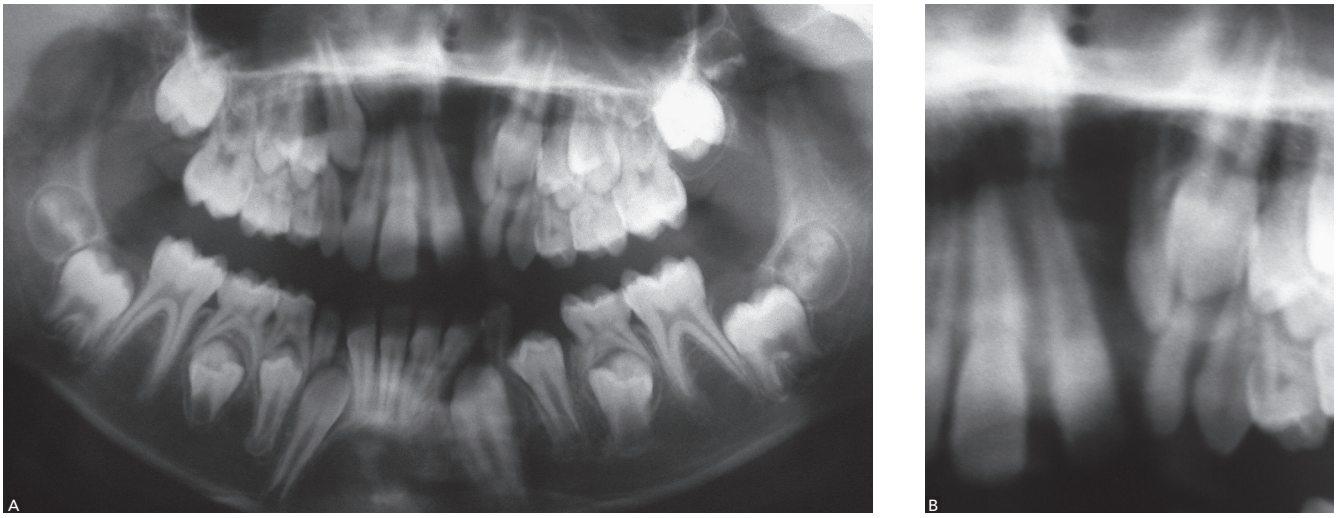


Figure 6 - A) Radiographic image compatible to the alveolar bone defect in complete alveolar cleft. B) Detailed, the alveolar bone defect in complete alveolar cleft is observed. The pre-canine and canine teeth, in the cleft area, present favorable eruption path towards the bone defect.

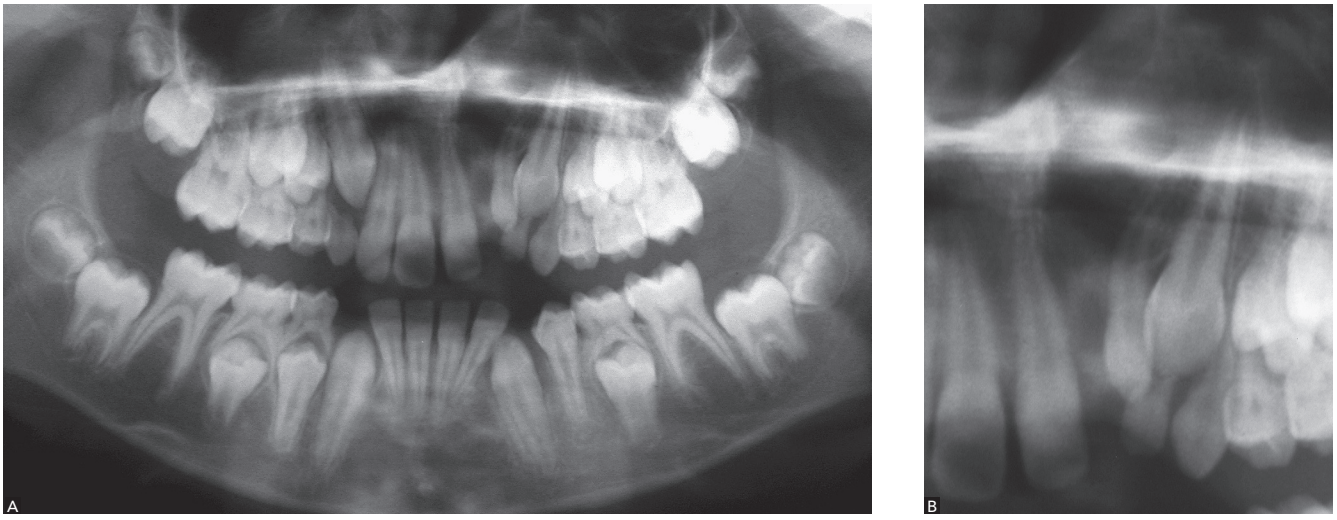


Figure 7 - A) Panoramic radiograph shows the procedure of secondary bone grafting performed using allogeneic bone, obtained from human bone bank, to restore the alveolar ridge and allow the eruption of canine and pre-canine by bone grafting. B) This section, obtained from the panoramic radiograph, illustrates the grafted region.

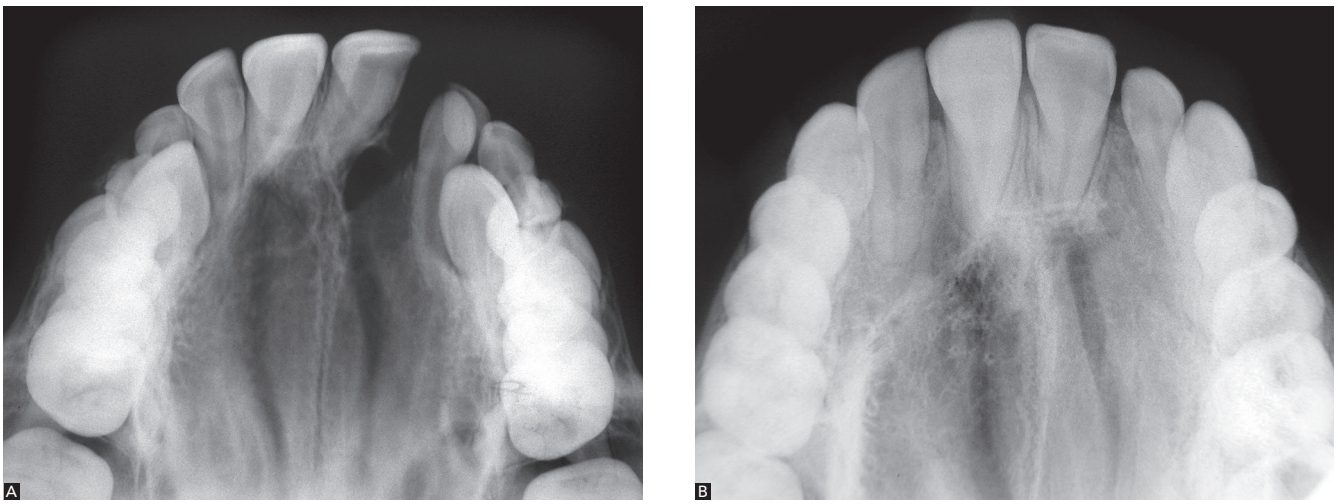


Figure 8 - A) Occlusal radiograph before secondary bone grafting. B) Occlusal radiograph after bone grafting. The comparison of occlusal radiographs, before and after bone grafting, reveals the structural difference on the alveolar ridge, assigned to the bone grafting.

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Figure 9 - **A)** Right lateral intraoral photograph. **B**) Frontal intraoral photograph. **C**) Left lateral intraoral photograph. By the end of the orthodontic treatment, the left pre-canine substitutes the lateral incisor. There is evidence and space enough for the increase of the pre-canine crown. **D**) Upper occlusal photograph. **E**) Lower occlusal photograph.

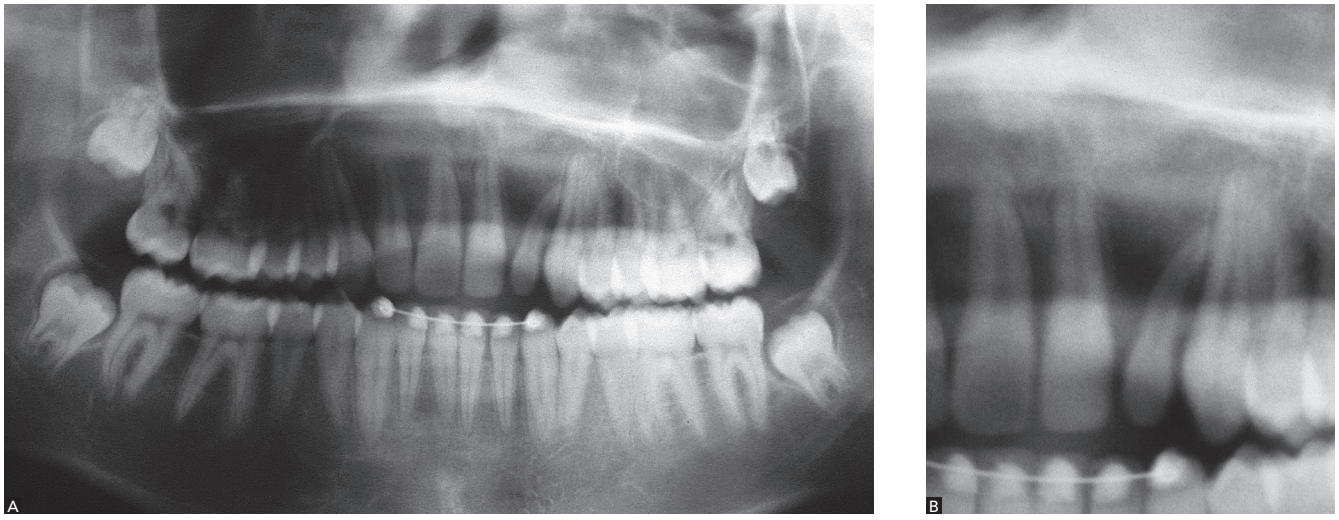


Figure 10 - **A)** Panoramic radiograph by the end of the orthodontic treatment. The periodontal condition illustrated on the image is very favorable. **B**) This image demonstrates more clearly the favorable periodontal condition.

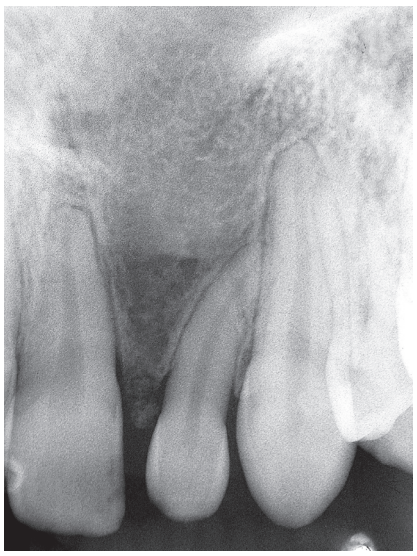


Figure 11 - In this radiographic image, the pre-canine tooth is observed replacing the corresponding lateral incisor, and fine periodontal support can also be observed.

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DISCUSSION

When choosing the grafting material to reconstruct the alveolar processes, the decision of establishing a donor site on the receptor itself can give the procedure a dimension of greater amplitude, once the post-surgical morbidity becomes more significant, contributing decisively on the patient recovery. This factor was shown to be relevant on the decision for the use of alternatives to autogenous sources.

The main characteristic assigned to allogeneic bone consists in its versatility, with osteoconduction and osteoinduction potential assigned to its macroscopic characteristics. Both potentials must be considered when planning to use it or when the results are evaluated. Why this double potential of osteoconduction and osteoinduction? Which factors contribute to this?

Despite the absence of osteogenic phase, the process of incorporation of allogeneic graft is similar to of autogenous graft. The graft is placed in a dead area, filled with blood clot. The dead area is hypoxic (PO_2 of 5 to 10 mmHg) and acidotic (pH 4 to 6), containing platelets, leukocytes, red cells and fibrin, in a complex structure. Associated with the graft, sectioned capillaries were observed, with clot and exposed endothelial cells. Externally to the periosteal closure, the tissue is normoxic (PO_2 of 45 to 55 mmHg) and presents physiological pH (pH of 7.42). The release of growth factors (PDGF, TGF-b and IGF), from the platelet degranulation, exert primordial functions on the regenerative process. It is highlighted the angiogenic activity of capillary sprouts in the graft interior, by the induction of mitosis in endothelial cells, differentiation and proliferation of fibroblasts and pre-osteoblasts in functional osteoblasts, secretion of bone matrix by osteoblasts and of collagen matrix by fibroblasts, providing support to the capillary growth. In autogenous grafts, the capillaries appear in the graft on the third day and the complete penetration is visualized between the 14th and 17th day.

In autogenous grafts, the formation of bone phase I is originated from endosteal osteoblasts that delimit the trabecular bone surfaces. This bone from phase I is immature and disorganized, with absence of Haversian systems and little structural integrity. It develops four weeks after grafting. The end of the graft revascularization eliminates the small tension of oxygen necessary to keep the macrophages activity. They leave the area since they are no longer necessary for the graft maintenance. The phase I bone will, mandatorily, be subjected to a process of resorption/apposition, which will lead to formation of a mature bone, with lamellar architecture and Harvesian systems, denominated phase II bone. With a developed periosteum and endosteum, it is a self-sustaining bone, with complete structural integrity.

The maturation of the regenerated bone involves the IGF and the bone morphogenetic proteins. These are insoluble acidic proteins, released by osteoclastic resorption on the process of normal bone remodeling, which occurs 0.7% a day in normal bone, and can occur as fast as 5 to 8% a day in a graft in maturation.

The release of BMP and IGF links the bone resorption to neoformation, acting in adjacent pluripotent cells and pre-osteoblasts, inducing its proliferation and differentiation in functional osteoblasts, which secrete, actively, the bone matrix. This way, the grafting cycle develops from a cell transplantation, which is placed in a complex biomechanical environment, to a mature and functional bone, which is self-sustaining by means of a normal cycle of resorption/remodeling.[9,15]

The BMPs present in the osteoconductive allogeneic matrix are glycoproteins classified into 15, being 2, 4 and 7 those of greater influence on the osteoinductive process, since they effectively act on the differentiation of pluripotent mesenchymal cells in osteogenic precursors. When different samples of allogeneic bone tissue, from different bone banks, were subjected to immunohistochemical analysis, it was observed that the best clinical results (bone formation) were associated with presence of BMPs 2 and 7. Therefore, the osteoinductive potential is variable from bank to bank and, in the same bank, from donor to donor.[11] Another physiological principle of integration of any bone transplant is the osteoclastic resorption, considered biostimulation to bone neoformation and primary factor on the process of graft remodeling, influencing its mineralization proportion. The process of graft incorporation with initial formation of immature primary bone and its maturation in secondary lamellar bone is also related to the graft vascularization, associated with the graft characteristics and the receptor site. Structurally, the corticomedullary grafts are composed of a cortical and a medullary por-

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tion. The medullary is much more easily vascularized and incorporated; however, more easily resorbed, in relation to the cortical. The particulate grafts, however, are very easily vascularized and, consequently, resorbed. One of the factors for choice of graft is the type of defect that will be reconstructed. The influence of the allograft processing must also be considered, since it will affect its osteoregenerative potential. The method for allograft processing must ensure the sterilization, preservation of biological characteristics and reduction of antigenicity.[26] The bone that was used here undergoes a process of acid treatment with sterile HCl associated with a solution of Ca at 5%, water pumping for 12 hours, lyophilization and storage at 80°C, which ensures its availability for five years. Such procedure ensures its sterilization and the preservation of osteoinductive and osteoconductive biological properties. However, the careful selection of donor is fundamental to prevent transmission of infectious diseases. The bone allografts are an alternative to reconstruction of alveolar clefts. On the one hand, the graft with structural (cortical/medullary) and biological characteristics (amount and type of BMPs present) and, on the other hand, the receptor, with its inherent osteoclastic activity, are the variable that will affect the clinical results.

CONCLUSION

The bone allografts are alternatives for reconstruction of alveolar clefts. The advantages as (1) elimination of the donor area, (2) bone available in adequate shape and amount, (3) in addition to the osteoregenerative biological properties described in the literature, stimulate its use.

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1. Registration of clinical trials

Clinical trials are among the best evidence for clinical decision making. To be considered a clinical trial a research project must involve patients and be prospective. Such patients must be subjected to clinical or drug intervention with the purpose of comparing cause and effect between the groups under study and, potentially, the intervention should somehow exert an impact on the health of those involved.

According to the World Health Organization (WHO), clinical trials and randomized controlled clinical trials should be reported and registered in advance.

Registration of these trials has been proposed in order to (a) identify all clinical trials underway and their results since not all are published in scientific journals; (b) preserve the health of individuals who join the study as patients and (c) boost communication and cooperation between research institutions and with other stakeholders from society at large interested in a particular subject. Additionally, registration helps to expose the gaps in existing knowledge in different areas as well as disclose the trends and experts in a given field of study.

In acknowledging the importance of these initiatives and so that Latin American and Caribbean journals may comply with international recommendations and standards, BIREME recommends that the editors of scientific health journals indexed in the Scientific Electronic Library Online (SciELO) and LILACS (Latin American and Caribbean Center on Health Sciences) make public these requirements and their context. Similarly to MEDLINE, specific fields have been included in LILACS and SciELO for clinical trial registration numbers of articles published in health journals.

At the same time, the International Committee of Medical Journal Editors (ICMJE) has suggested that editors of scientific journals require authors to produce a registration number at the time of paper submission. Registration of clinical trials can be performed in one of the Clinical Trial Registers validated by WHO and ICMJE, whose addresses are available at the ICMJE website. To be validated, the Clinical Trial Registers must follow a set of criteria established by WHO.

2. Portal for promoting and registering clinical trials

With the purpose of providing greater visibility to validated Clinical Trial Registers, WHO launched its Clinical Trial Search Portal (http://www.who.int/ictrp/network/en/index.html), an interface that allows simultaneous searches in a number of databases. Searches on this portal can be carried out by entering words, clinical trial titles or identification number. The results show all the existing clinical trials at different stages of implementation with links to their full description in the respective Primary Clinical Trials Register.

The quality of the information available on this portal is guaranteed by the producers of the Clinical Trial Registers that form part of the network recently established by WHO, i.e., WHO Network of Collaborating Clinical Trial Registers. This network will enable interaction between the producers of the Clinical Trial Registers to define best practices and quality control. Primary registration of clinical 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.

WHO proposes that as a minimum requirement the following information be registered for each trial. A unique identification number, date of trial registration, secondary identities, sources of funding and material support, the main sponsor, other sponsors, contact for public queries, contact for scientific queries, public title of the study, scientific title, countries of recruitment, health problems studied, interventions, inclusion and exclusion criteria, study type, date of the first volunteer recruitment, sample size goal, recruitment status and primary and secondary result measurements.

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Consequently, authors are hereby recommended to register their clinical trials prior to trial implementation.

Yours sincerely,

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