ISSN 2176-9451

Dental Press Journal of ORTHODONTICS

Volume 17, Number 4, July / August 2012



Dental Press International

Dental Press Journal of
ORTHODONTICS

v. 17, no. 4 July/August 2012

Dental Press J Orthod. 2012 July/August;17(4):1-176 ISSN 2176-9451

Indexing:

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Dental Press Journal of Orthodontics
v. 1, n. 1 (set./out. 1996) - . -- Maringá : Dental Press International,
1996 -

Bimonthly
ISSN 2176-9451

1. Orthodontic - Journal. I. Dental Press International.

CDD 617.643005

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Dental Press Journal of Orthodontics
(ISSN 2176-9451) continues the **Revista Dental Press de Ortodontia e Ortopedia Facial** (ISSN 1415-5419).

Dental Press Journal of Orthodontics
(ISSN 2176-9451) is a bimonthly publication of Dental Press International
Av. Euclides da Cunha, 1.718 - Zona 5 - ZIP code: 87.015-180
Maringá / PR, Brazil - Phone: (55 044) 3031-9818
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EDITORIAL

"An Orthossaurus in social networks"

Is it worth looking without seeing?
Johann W. von Goethe

I bought my first computer in the early '90s, when I was a resident of the Orthodontics department at Centrinho, USP. However, although I consider myself at the vanguard, my reception to the WWW network took a little longer. It was partly Bill Gates' fault. He made me believe that this tool would not bring any personal or professional benefits. What a mistake ...

In the compass of Gates, I must confess that for a long time I was blind to the social networks. Prejudice, indeed: Guilty as charged, justified by the lack of time. Until one day an undergraduate student got me to know Orkut. After the first contact, I inferred that I should not fray my precious time line with that trinket, and I settled more-and-more to the principle of Gates. It would be my funeral if it were not this parenthesis I do now: here comes "Facebook" to remove myself from the bed of death. It was when I buried the epidermis of an *Orthossaurus odonthorrex* which lived in me right in the century of the communication revolution.

This time it was a graduate student. I staged disdain, again; an unfocused look, blurry vision typical of a dinosaur. The prejudice was implicit, something just unacceptable to an educator. After the initial repulsion, I asked him to introduce me to this "face". At the beginning of the presentation it seemed an improved version of Orkut, but after much polishing - by curiosity - I ended up starting a journey full of news.

As anyone who uses social networks, I rediscovered friends who I for long didn't meet, people who I would never have had the opportunity to be in contact if it was not the creation of this powerful communication tool. I also recognized several renowned orthodontists, hooked by the social network. Professionals for whom I have effusive admiration. If all these people are in it, why would not I, this Mesozoic descendant? Then I broke the shackles of prejudice and my concealment of cyberspace. I left the park.

A little more snooping, I found a tool that could help me with my role as an educator, researcher, editor and clinician. There were the groups, space in which people are added with affinity to a particular theme. A kind of ghetto. In the dive, I realized the gap and created two of them. I already felt, by then, that my reptile skin had been tattooed in the past.

To the first group I gave the nickname of Brazilian Orthodontics, which came to a thousand members in one month, thanks to many friends. Now over 1,500 professionals. This group provides notifications with diverse interests within the specialty, such as disclosures of research and events, discussion of clinical cases and sometimes some personal struggles I have the arduous task of mediating.

I confess, however, that the favorite son is the second group, called pompously Brazilian Dental Research. It is close to 2,000 members and still full of deeply respected researchers, publishers, teachers and students from all states in this (in) finite Brazil. Research publications, editorials, information and interesting discussions of scientific methodology - including Biostatistics – public contests for professors and scientific events are constantly being released by the group. It was by the network, thanks to Prof. Saul Paiva - UFMG, by who I became aware, for example, of the meeting of the Brazilian Association of Scientific Editors, held in July of this year. One of the best events I attended in the last decade. Is there something more useful?

If today I remember that Jurassic time lived in the transition of my dinosaur dentition, it was to over myself from the prejudice, only in the metaphorical sense, thus, I apologize for those who do not participate in social networks; also for understanding that we live in the era of communication and we cannot, ever, renounce, for images and documents are spread in seconds. Much more is to come. Knowledge is power, and communication generates dissemination of knowledge; so, these events, interwoven, reduce inequalities and increase sociability in the anthropological sense. On the other hand, with so much access to information, we still cannot distance ourselves from the real meaning of reptile prejudice because it is stuck to a stereotype.

I would not like to advocate that every orthodontist should participate in the social network, or to abandon the pachydermal fossilization - never, ever. I'm just reporting this learning as a way of advising those who have not had the courage or sufficient stimulus for searching information on this attractive tool. Those who already know, I invite you to participate in the so interesting created groups and visit the information posted. You will notice that the time spent initially will be returned with interest, just click without having to roar. To paraphrase John Munsell: If content is king, communication is the queen; so, save the Queen.

Enjoy the reading!

David Normando - Editor in Chief
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Cytotoxicity of orthodontic materials – The search for the perfect orthodontic material

Matheus Melo Pithon[1]

For several years, experimental studies in Orthodontics have attempted to define the mechanical properties of various components of orthodontic appliances to improve bracket[1] and orthodontic cement[2] shear bond strength, reduce friction of wires and brackets,[3] increase force of elastics[4] and achieve several other improvements.[5,6,7] However, adverse reactions of the oral soft tissues have raised the interest of researchers in determining the biological effects of these materials, that is, their biocompatibility (Fig 1).

Biocompatibility may be defined as the capacity of a material to perform its specific functions when applied to living tissues of certain hosts without causing any damage or harm.[8] Orthodontic brackets, for example, should remain in the patient's oral cavity for a mean of 36 months, in close contact with the mucosa, but should not cause any irritation.

As the control of the use of laboratory animals has grown stricter, in vitro tests had to be developed and standardized to detect the possible toxicity of the devices to be used in human beings, particularly those for clinical applications, such as biomaterials, which should not expose the patient's organism to any adverse reactions or injury.

According to the International Standard Organization (ISO 10993), *in vitro* cytotoxicity trials should be the first tests to evaluate the biocompatibility of any material to be included in biomedical devices. Only after confirmation of their non-toxicity should the investigation of the product's biocompatibility go on, with the necessary trials using laboratory animals.[10]

Several *in vitro* methods are available to test the toxicity of biomaterials.[11,12] Most tests place the material directly or indirectly in contact with a mammalian cell culture, after which cell changes are evaluated using different techniques, such as the incorporation of vital dyes or the inhibition of cell colony formation.[13] The most common parameter to evaluate toxicity is cell viability, which may be demonstrated using vital dyes, such as neutral red.[12] Several substances damage cell membranes and decrease neutral red uptake and bonding. Therefore, live cells can be distinguished from damaged or dead cells by measuring the intensity of the cell culture staining using spectrometry.[12]

In vitro methods have advantages over *in vivo* tests, such as the greater control of experimental variables, easier access to significant data and, in many cases, shorter test times.[12]

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How to cite this article: Pithon MM. Cytotoxicity of orthodontic materials – The search for the perfect orthodontic material. Dental Press J Orthod. 2012 July-Aug;17(4):2-3.

Submitted: february 02, 2012 - **Revised and accepted:** march 20, 2012

» The author reports no commercial, proprietary or financial interest in the products or companies described in this article.

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

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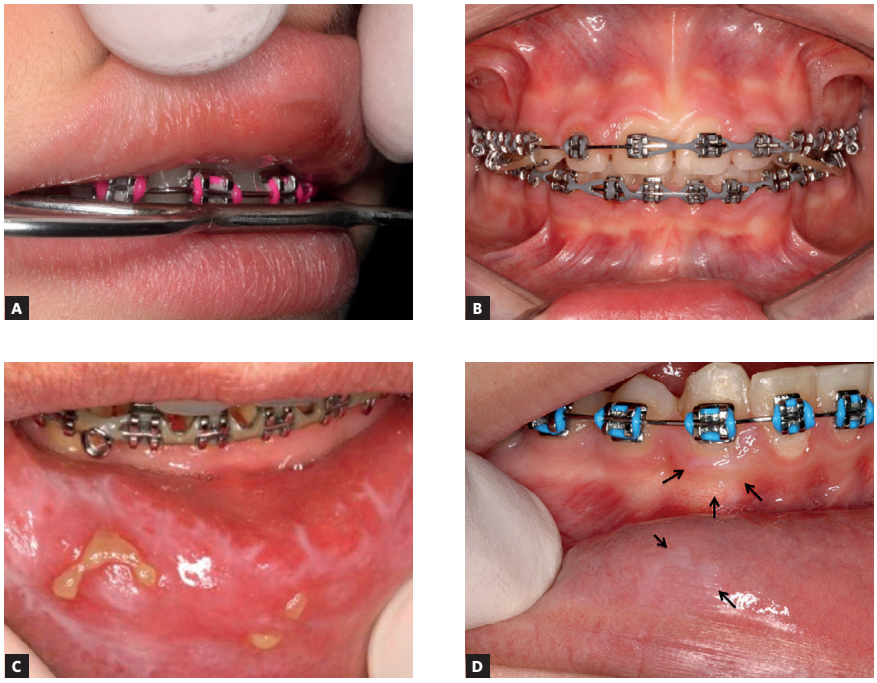


Figure 1 - **A**) Lip lesion due to contact with orthodontic solder of extraoral appliance. **B**) Inflammatory gingival reaction to contact with bracket bonding resin in patient with good oral hygiene. **C**) Lesion in mucosa after use of intermaxillary elastics. **D**) Lesion in gingiva and lower lip mucosa due to contact of self-conditioning agent in adhesive system.

Biological tests are important because a material to be used in the oral cavity should be atoxic and non-absorbable by the circulatory system and should not injure oral tissues. Non-biocompatible materials may be mutagenic or affect inflammation mediators, which may lead to systemic responses, such as toxic, teratogenic or carcinogenic effects.[14] Such materials should be free of agents that may cause allergic responses in sensitive individuals.

The elucidation of how orthodontic materials behave when in contact with live tissues may bring answers to several clinical questions, such as: Why is the patient's gingiva hyperplastic even when oral hygiene is excellent? Is the pain assigned to the elastic bands caused only by their movement during use or also by their toxicity when in contact with the gingiva? Important to note that success in clinical orthodontics does not only depend on mastering corrective techniques to achieve ideal dental occlusion, but also demands the application of biosafety norms and the attention to the local and systemic consequences of the use of orthodontic materials.

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an interview with

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Professor J. Martin Palomo is a graduate of the Ponta Grossa State University and proudly hails from Ponta Grossa, Brazil. He was selected to specialize at the prestigious Case Western Reserve School of Dental Medicine (CWRU) in Cleveland Ohio and during his graduate training, began to feel that he could serve the profession more broadly through academics and specifically through imaging. Dr Palomo's ambition has always been to serve his native Brazil; he has worked in Curitiba, the mayorship of Manoel Ribas, and the university of UNIPAR, in Umuarama. While working as an orthodontist in Brazil, he was invited to return to CWRU and appointed to Clinic Director and Research Fellow of the Bolton Brush Center. Dr Palomo earned several awards for his teaching from the American Association of Orthodontics and chaired their Council on Education Leadership Implementing Evidence Based Dentistry. Today Dr. Palomo is the Director of Orthodontics and Chair of the Graduate Studies Committee at CWRU. He has built the premier imaging center in the Midwest and is busy authoring the American Dental Association position paper on the subject. He has assembled an award winning team of top notch researchers, clinical orthodontists, physicians, and graduate students who contribute to the profession. His ambition is to serve his native Brazil through authorship, speaking, meetings, and collaborations. Dr. Palomo is married to a periodontist and they have a 7 year-old daughter and three dogs.

Lincoln I. Nojima

How to cite this section: Palomo JM. Interview. Dental Press J Orthod. 2012 July-Aug;17(4):4-11.
Submitted: October 20, 2011 - **Revised and accepted**: March 01, 2012

» Patients displayed in this interview previously approved the use of their images.

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Three-dimensional analysis require the incorporation of didactic training during orthodontic residency, since orthodontists need training to analyze a CBCT image adequately. As a pioneer in 3D Imaging in academics, how is the 3D Diagnosis addressed at Case Western Reserve University? (Lucia Cevidanes)

Our patients are three-dimensional entities, and a three-dimensional representation is not only more accurate, but also easier to understand. Our residents find it is easier to locate landmarks in 3D images than in cephalograms. We do still teach a whole cephalometric course, and perform cephalometric analyses on every patient, so at this point our residents get more education than when we did only 2D. We have courses that teaches them how to analyze a 3D image, going slice by slice and looking for pathology and abnormalities outside of normal limits (Fig 1). I find it is great that while we are looking at these images, they are also taking courses on anatomy and pathology, and I noticed that they make more of a basic course to clinic connection now, than when they would only see panoramic and cephalometric radiographs. We also teach them how to use different software. We do find that we had to add more courses and class time, but this makes sense, since we are now working with more information, and doing more than before. In my opinion specialist need to do more, and provide a more comprehensive service. That to me is almost the definition of specialist.

What are you doing to interest young orthodontists in teaching and/or research after they finish their specialty programs? (Carla Evans)

I try to show our young residents and orthodontists, how rewarding it can be to be involved in academics, mostly to oneself. To be in contact with colleagues and have frequent discussions on current topics promotes mental stimulation, growth, confidence, and efficiency. It is like an ongoing continuing education course. It is an assurance that you will not do for the rest of your career the same thing you did as a fresh graduate. As G.V. Black said, "the professional has no right to be other than a continuous student", and sometimes this is not easy unless you have contact with such environment.



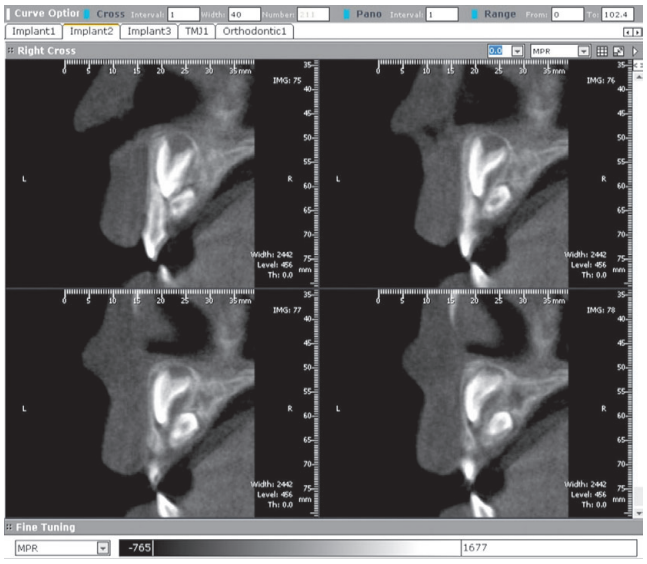


Figure 1 - A case of a 5 year-old girl where supernumerary teeth were found on a panoramic radiograph between upper permanent and deciduous central incisors. The treatment plan of extracting deciduous teeth in order to gain access to the supernumerary teeth was changed once the 3D image showed that the extra teeth were lingually displaced. The precise location through imaging allowed a very simple surgical flap and removal of the supernumerary teeth without touching either deciduous or permanent teeth.

What have you learned about facial growth and the response to orthodontic treatment from CBCT images? (Mark Hans)

As far as facial growth, we think the additional information collected through density values may be useful in identifying areas of resorption and deposition in the mandible, and provide an insight on growth direction of growth. We have ongoing projects on that area, and it looks promising. On the area of response to orthodontic treatment, there are a lot of tools available, that have shown how much change unknown to the orthodontist happens during treatment. Just the analysis of buccolingual inclination of molars show changes of 15 degrees that were not planned or desired. This may result in a less than stable result (Fig 2).

Have you implemented any innovative teaching methods in orthodontics? (Carla Evans)

Case Western Reserve University (CWRU) has a tradition of working with craniofacial imaging, with the first Cephalometer being invented by Dr. Broadbent, to the Bolton Standards, and pioneer work in three-dimensional imaging, which started with the combination of frontal and lateral cephalograms, and now CBCT. I am fortunate to be part of a team that has been implementing this pioneer work for a long time, and I think I have been able to contribute with courses such as "Advanced Craniofacial Imaging" given to orthodontic and pediatric dentistry residents where they work on their own computer on pre-selected images, some with pathologies, others without, and then train them on how to handle different situations. I think the courses nowadays need to be hands-on and interactive, and to work with CBCT and 3D imaging software, the student can only learn by doing it.

In the "Seminars in Orthodontics" issue where you were the guest editor, Dr. Lysle Johnston made an analogy between 3D Images and the movie "The Matrix", stating that we can only see what the programmers allow us to see. Can you comment on this statement and suggest care in the diagnostic interpretation to distinguish what can be artifacts of 3D rendering that shows or hides bone in the image? (Lucia Cevidanes)

One of the disadvantages of CBCT for both software and hardware is the lack of standardization at the moment. The same image may look diagnostically different in different software packages, and this is possible due to lack of regulation on what can be done by companies. The image in 3D may look prettier than the slices, but we teach at CWRU that if you want an answer you go to the slice mode and see it in the axial, sagittal, and coronal views. Analyses such as airway volume has also differences between software packages and unfortunately at this point cannot be used as cephalometric values, where we expect to see relative inter-software consistency. I am a big fan of Dr. Cevidanes, another Brazilian, who really leads the way in open source software packages, where to make an image pretty to sell more is not a priority.

Since this is one of your research lines in the Orthodontic Department at Case, in which mophologic and functional ways can the airways be analyzed through CBCT? (Matilde Nojima)

Even though the airway can be easily and automatically segmented by using most of the software packages available to orthodontists, it has not at this point shown diagnostic value. We have noted differences in airway volume for different craniofacial patterns, and have noted the opening of the airway in

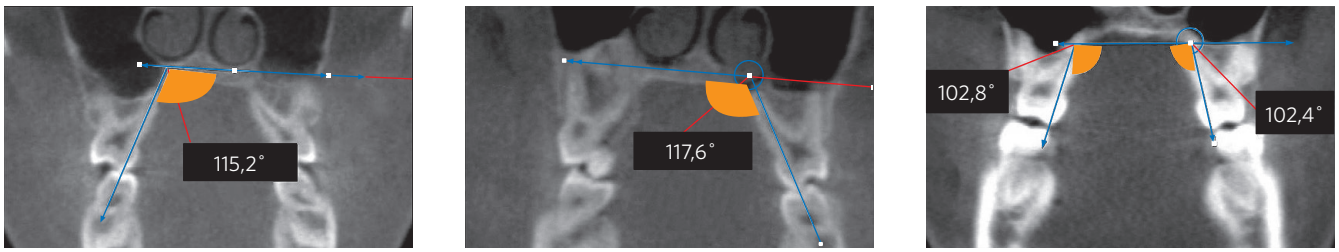


Figure 2 - The buccolingual inclination of posterior teeth can be accurately measured in the 3D images provided with CBCT. This can be valuable diagnostic information, which can help in the decision between palatal expanders or archwire expansion, and provide more control on changes that may be occurring without the orthodontist's knowledge. Such changes may play a role in the stability of the result.

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cases of mandibular advancement, due to appliances, orthodontic treatment, or surgery, but there is still a lot of work that needs to be done to make airway assessment useful and diagnostic of sleep or breathing disorders. At this point, I do not think we would take a CBCT just for airway assessment, but if the CBCT was taken for other motives, we should investigate the airway as part of our protocol (Fig 3).

With the current knowledge base available would you recommend traditional orthodontic records to be replaced by a single CBCT? Is this possible in clinical orthodontics? (Dauro Oliveira)

I don't think we can completely replace all orthodontic records with a CBCT image, but it can get very close (Fig 4). I think it could replace impressions since electronic models can be created from CBCT images, but even though the patient's face can be seen in a large field of view volume, it cannot replace the smile picture, the intra oral pictures, and lacks color (Fig 5).

Now, even though this is possible, I do not think that should be done in clinical orthodontics due to the ionizing radiation involved. The Board of Trustees of the American Association of Orthodontists (AAO) and American Academy of Oral and Maxillofacial Radiology (AAOMR) have appointed a council committed to form guidelines on when to use CBCT. It includes 4 orthodontists: Dr. Carla Evans (University of Illinois in Chicago), Dr. Kirt Simmons (Arkansas Children's Hospital), Dr. Lucia Cevidanes (University of Michigan), and myself, as well

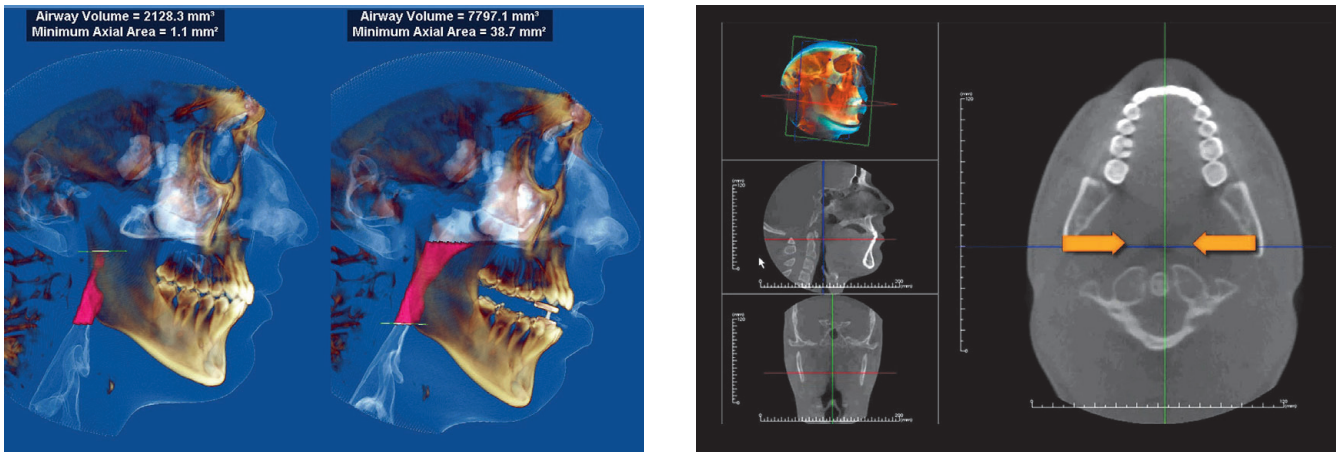


Figure 3 - Airway assessment in 3D evaluate more than just the lateral view, and allow the creation of both volumes and areas of maximum constriction. This cases shows a patient with severe obstruction of the airways with and without a removable appliance that protrudes the mandible and slightly opens the vertical. The changes that can be seen in the axial slices would not be detected in a cephalometric radiograph.



Figure 4 - The CBCT can be used to create electronic models of the dentition, that has root information, without the need of an impression. Here a frontal photograph was also added to the record in order to add color information.

as three radiologists: Dr. William Scarfe (University of Louisville), Dr. Mansur Ahmad (University of Minnesota) and Dr. John Ludlow (University of North Carolina). Latest drafts already show the advantages of sometimes combining traditional 2D images with smaller field of view 3D images. This is the direction where things are going in my opinion. We have to think of CBCT as a radiographic tool in our armamentarium. If we have a clinical question, we have to see which tool would better answer it. Sometimes a panoramic image is enough, some other times we would not be able to fully answer without a CBCT image. It is a clinical decision made by the healthcare provider.

Under what circumstances would you recommend a CBCT image be reviewed by an Oral and Maxillofacial Radiologist? (Mark Hans)

At CWRU we review every image in all three planes of space, which takes just a few minutes, following protocols where the image is first oriented in space similar to what we do with cephalometrics. Anytime we see anything that does not look like it is within normal limits or have any doubt, we refer for a radiological review. We do not send every image, since as orthodontists we have the anatomical knowledge of how things should look and what can be a problem or not. We did not use to send our cephs and panos, but similarly would look for pathology and abnormalities and refer when we would find something outside normal limits. In addition to this protocol, we always offer a radiological reading to the patient or parent, in case they want it regardless.

What's your position when related to risks of ionizing radiation received by patients? Does any dose represent a cancer risk? (Lucia Cevidanes)

I don't think this is a matter of opinion or belief, but of facts. One of the best descriptions I have seen lately is from a governmental commission called USNRC (United States Nuclear Regulatory Commission) whose office of public affairs puts out a fact sheet. This four page document does a great job showing the lack of knowledge we have on this topic at this time. It speculates that low levels of radiation would heal and not be cumulative, but since we do not have firm evidence at this point, we should act in a conservative way. There are groups that think ionizing radiation has different effects depending on the dose, at low doses it can even be beneficial to the patient, and at high doses detrimental. Since we do not have any reliable data on low dose effects, we should act in a worst case scenario event, and try to reduce as much as possible.

The use of CBCT as a diagnostic tool in clinical orthodontics has been growing, but not as rapidly. A possible obstacle seems to be commercially available software costs. What could be done to help with this problem? (Lincoln Nojima)

There are a lot of software package options as freeware, and open sorce, and many more to come. There is a lot of support and interest in that area, so hopefully this will not be an obstacle for long. On the other hand, software companies provide a product that may be the result of years of work,

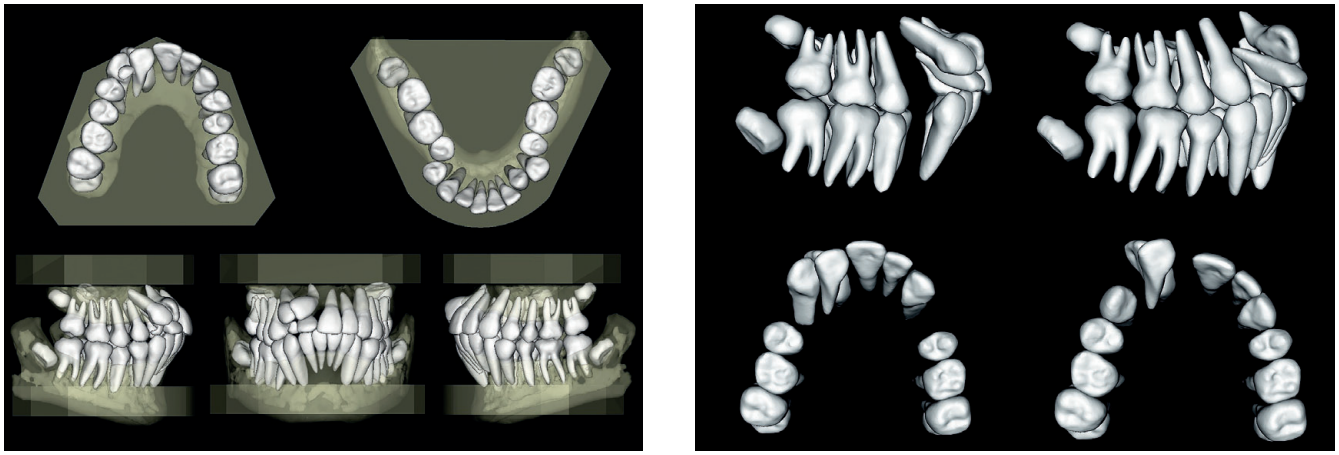


Figure 5 - The CBCT created electronic model can also be used to replace models created from impressions, and can also be used in virtual treatment planning setups. This case shows the tipping back of cuspids after a bicuspid extraction, from both lateral and occlusal views.

and employment of several people. If a company does a good job, puts a good quality product in the market, and stands behind it, I think the company deserves to be paid and supported for this.

Which benefits can 3D imaging offer to the orthodontist to improve the stability of a final result? (Lincoln Nojima)

One of the challenges that the orthodontist faces for every patient is to start a cases that present with a malocclusion, but shows proper equilibrium and is presently stable, then change it, and reach again stability and equilibrium in the final result. The only way to do this is with proper knowledge and proper control. 3D imaging can give more diagnostic information such as buccolingual inclination of teeth and position of root apices (Fig 6), that can be the additional information lacking in the proper knowledge section. The control still lies in the orthodontist's hands.

Which are your recommendations for the standardization of 3D superimposition? (Matilde Nojima)

3D superimposition in my opinion combines the old with the new. Our knowledge of stable areas and structures have to be used as places of superimposition, but instead of manually selecting those points, and ending up with just a few landmarks, software packages are able to detect similarities not visible to the human eye, and superimpose on thousands of points. This can result in a more reliable superimposition. The visualization at this point is still not optimal, and in my opinion is better assessed in the slice mode than in a 3D rendering. But software improvements are happening so fast that I would not be surprised if this is available at the time of this print.

Is there a reliable 3D cephalometric analysis? What has come from the expert's discussions that happen every year in Cleveland in relation to these analysis? (Dauro Oliveira)

Several analyses have been suggested, and software packages already allow the users to pick right and left landmarks separately. To my knowledge, no technique has been widely accepted, in the way the Down's analysis was for the lateral radiograph. But to put in perspective, it took 17 years since the invention of the cephalometer for the Down's analysis to be accepted, and it took 29 years for a superimposition analysis. Since to see an image in 3D is more of a game changer, the speculation is that we cannot limit the information to what we used to do with images that showed less information. For 3D images we may need to think in volumes, areas, and density values, rather than lines and angles.

There has been a great deal of controversy over the use of CBCT for routine orthodontic cases. What is your opinion on the role CBCT will play in the future of orthodontics? (Mark Hans)

Routine means automatically for everybody. I don't think routine should be applied for any radiological tool. There has to be a clinical examination prior to ordering any radiograph. That everybody received a ceph is as wrong as everybody receiving a CBCT, because of the ionizing radiation and our lack of knowledge on what low doses of radiation may do to our patient. I do think that if radiation was not an issue, we would probably only need CBCT, and would never take a pano or ceph again, but this is not the world we live in at this time.

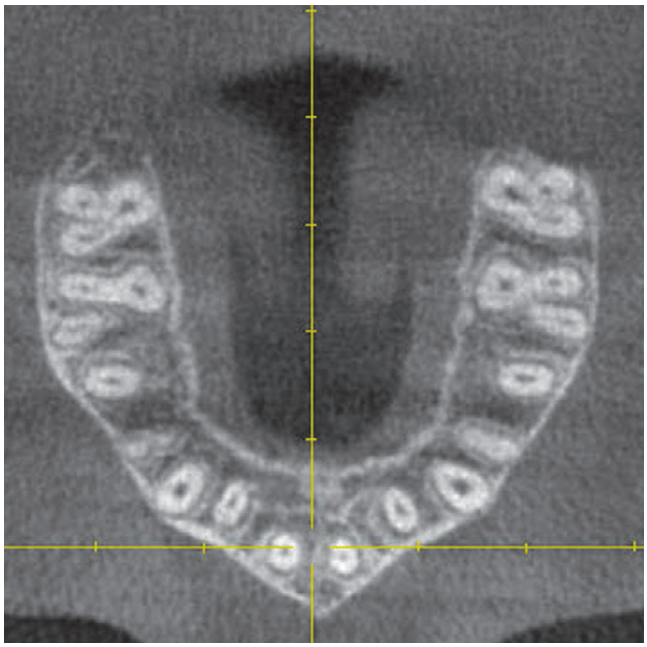


Figure 6 - An axial view of the root apices can give important information about incomplete correction or torque discrepancy. This view is impossible to obtain with traditional radiography.

How do you keep up with new techniques and technology related to CBCT? (Carla Evans)

I try to remain a constant student, and never assume I know anything. To me, the minute you think you know something, you stop learning. I still read journals, I go to meetings, I talk to other professionals, I talk to companies, etc... But I also make an effort to think outside of the box. Medicine has been working with 3D imaging and CT for a while now. I try to see what was done right and avoid what was done wrong. If it is a hardware question, I ask an engineer, if it is a radiation effect question, I ask a radiation biologist. I see that sometimes we have the tendency to only ask dentists or orthodontists, and ignore the fact that there are people that can offer a completely different perspective. This is one of the things I enjoy the most about working in an university environment, the access to experts in completely different areas.

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Advancements in the knowledge of induced tooth movement: Idiopathic osteosclerosis, cortical bone and orthodontic movement

Alberto Consolaro[1], Renata Bianco Consolaro[2]

Moving teeth orthodontically through the dense trabecular bone and cortical areas may require a reduction in the intensity and/or concentration of the applied forces. In part, the orthodontic applied forces are dissipated and reduced by bone deflection, which normally occurs by a slight degree of elasticity of bone tissue in normal conditions. In areas of dense trabecular and in cortical bone this deflection should be insignificant or nonexistent. If there is no reduction in the intensity of the forces in these mentioned regions, the entire force will focus on the structure of the periodontal ligament, increasing the risk of death of cementoblasts, hyalinization and root resorption. Further studies could assess the prevalence of these consequences in populations selected for this purpose, so that would no longer be randomly observed notes.

Keywords: Cortical bone. Idiopathic osteosclerosis. Chronic focal sclerosing osteitis [osteomyelitis]. Orthodontic movement. Induced tooth movement.

The orthodontic movement depends on the application of forces to the tooth promoting compression of the periodontal ligament. The deformation of cells and their cytoskeletons, in addition to the reducing blood flow and hypoxia, lead to cell stress with increased release of mediators that stimulate bone resorption in the surface of the periodontal alveolar bone. Thus, teeth move orthodontically.

In training for the application of orthodontic forces, it is common to have uniformity in the procedures. However, the bone has a great variability in the trabecular bone density, as well as in its cortical thickness and morphology of the bone crest.

This extreme variability, when extreme, may influence significantly in more or less symptoms during orthodontic movement as well as the risk of root resorption.

TRABECULAR BONE DENSITY

The density of trabecular bone varies according with the skeletal region. In the maxilla, the variability of the trabecular bone density is large, even when considering different areas of a same maxilla or mandible.

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» The authors report no commercial, proprietary, or financial interest in the products or companies described in this article.

How to cite this article: Consolaro A, Consolaro RB. Advancements in the knowledge of induced tooth movement: Idiopathic osteosclerosis, cortical bone and orthodontic movement. Dental Press J Orthod. 2012 July-Aug;17(4):12-6.

Submitted: March 26, 2012 - **Revised and accepted**: march 31, 2012

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This variability is related to structural adaptation to functional demands. The more physical or biologically required, within the normal range, the denser the trabecular bone will be, the marrow spaces will become smaller and in greater number in the radio and tomographic[1] images (Figs 1 and 2). The bone cells work in the remodeling to adequate the tissue to functional demands by increasing or decreasing their structures. Thus, the trabeculae may be bigger or smaller, narrower or wider; thus, the cortical may increase or decrease its thickness according to the functional demands required (Figs 1 and 2).

In images, the denser the trabecular bone, we tend to say that the same is suffering sclerosis. The term bone sclerosis is usually reserved for the densest areas of trabecular bone, where it is assumed that passed the normal morphologic limits.[2] In some texts sclerosis is used in place of the term bone condensation.

An area can typically presents with bone as dense as the anterior region of the mandible, without which we must call it as it represents a bone sclerosis of trabecular variability given a functional demand. When a certain situation or illness increases bone density usually adds the terms sclerosing or condensing to its name, especially for being a pathological nature.

When the trabecular bone present is less dense, it tends to assert that it is getting loose, spongy or yet refers to these as areas of bone rarefaction, by analogy to thin air. In regions of the mandibular angle or later the upper and lower third molars, including the tuberosity of the maxilla, there are patients with very loose areas or with normal bone rarefactions.

Focal Sclerosing Osteitis *versus* Idiopathic Osteosclerosis

The inflammatory osteitis is located, restricted to focal areas and less aggressive, which may involve the various components of bone.[2] Almost always related to aggressive agents of low intensity and long duration, such as endodontic and periodontal lesions (Figs 1 and 2). In chronic periapical lesions a localized inflammation and thin bone in the periapex is commonly established , and finally an osteitis in these cases are given specific names such as periapical granuloma, chronic dentoalveolar abscess and other well-known names. These areas serve for the thin bone to give way to exudade fluid and cells and inflammatory infiltrate, respectively.

In bone rarefaction, the causes act directly on the site, but the adjacent bone receives even smaller stimuli that accumulate the same inflammatory mediators, but in lower concentrations which reverse the stimulation of resorption to bone

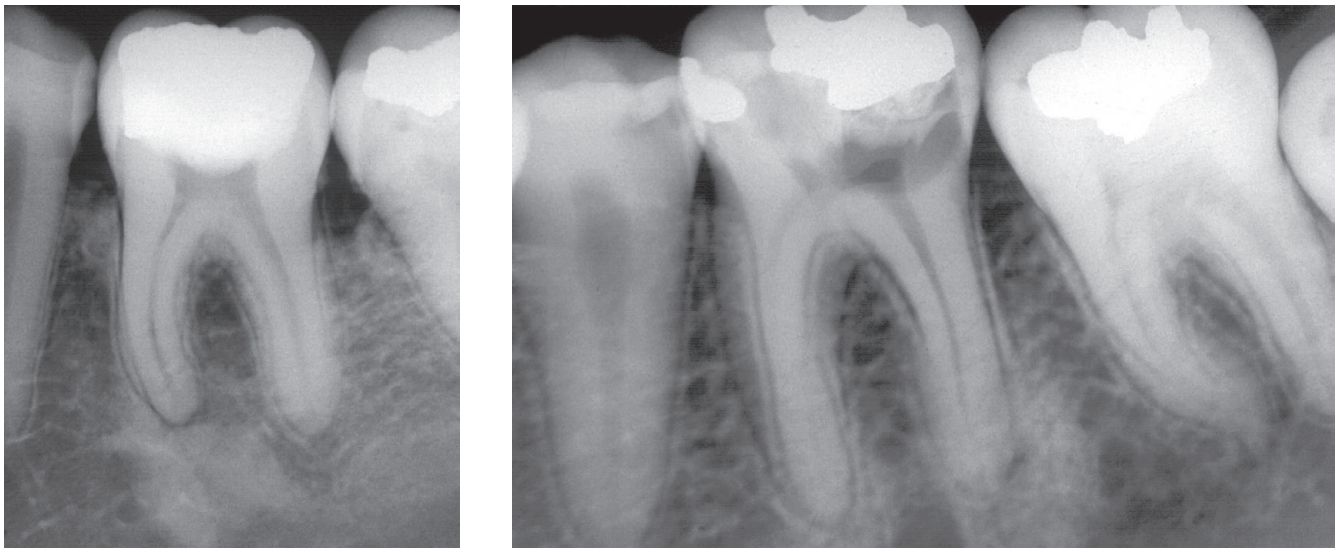


Figure 1 - Focal chronic sclerosing osteitis related to pulp necrosis and chronic periapical lesion, with small and irregular thin bone areas around the root canal opening, with predominant radiopaque images in the surroundings of thin bone areas.

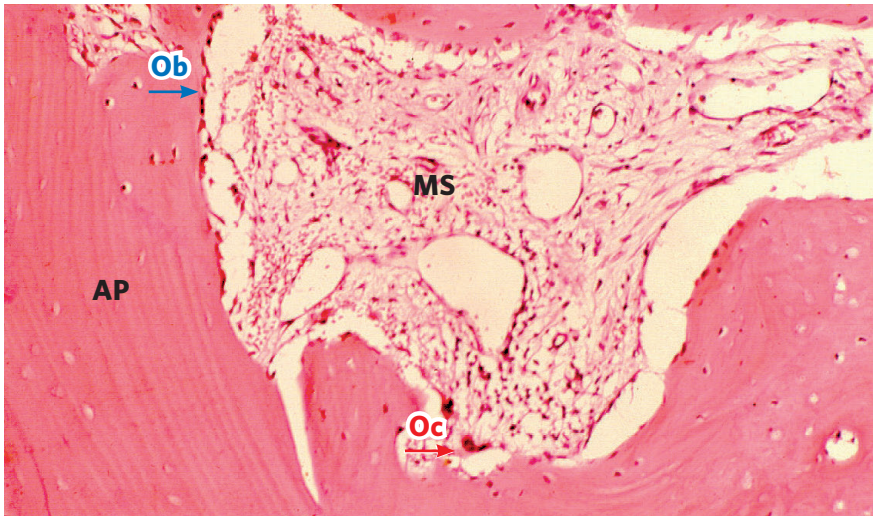


Figure 2 - Focal chronic sclerosing osteitis, demonstrating reduction of the medullary space (MS) filled in by conjunctive tissue with a discreet and difuse mononuclear infiltrate. The trabeculae are thick, with well defined layers of apposition (AP). Ob=osteoblasts; Oc=osteoclastas. (HE, 25x).

formation (Figs 1 and 2). The adjacent bone thereby increase its density and suffers sclerosis. The osteitis, as a whole, starts to present several sclerotic areas around the rarefact area.[2] In most affected cases radiopaque or neighboring dense areas predominate in the overall image of the process. In these cases the lesion is now diagnosed as Chronic Focal Sclerosing Osteitis. In some texts and reports it can be named as Chronic Focal Condensing Osteitis. The term "focal" can often be replaced by the term "local".

If the cause of Chronic Focal Sclerosing Osteitis is removed the inflammation process disappears, and, in general, the region remains indefinitely with a bone sclerosis which will be reshaped with time, even though approximately 30% of the cases no longer return to normal. In other words, with root canal therapy, dental extraction, periodontal treatment or any other therapeutic approach, a focal sclerotic bone area may indefinitely remain in that place.[2] After a few months or years, with remodeling and morphological upgrading of the site, without a prior well documented history (Fig 3), it will be very difficult to understand or identify any cause that induced that "abandoned" focal sclerotic bone area.

The term "Idiopathic Osteosclerosis" — also known as Dense Bone Isle or simply Focal Idiopathic Bone Sclerosis — is the most commonly used to identify focal sclerotic areas without identifying the cause-effect relationship (Fig 3). They are irregular and located radiopaque areas which continue naturally with the surrounding trabeculae without any line or radiolucent halo in outline or limit. The presence of a radiolucent halo indicates a fibrous capsule, which is typical of neoplastic diseases such as Fibrodysplasia Ossificans, osteomas, and odontomas, for example.

The Idiopathic Osteosclerosis without an identifiable cause, may have been earlier a Chronic Focal Sclerosing Osteitis with defined cause which was eliminated, but without documentation of their previous history it is impossible to make definitive

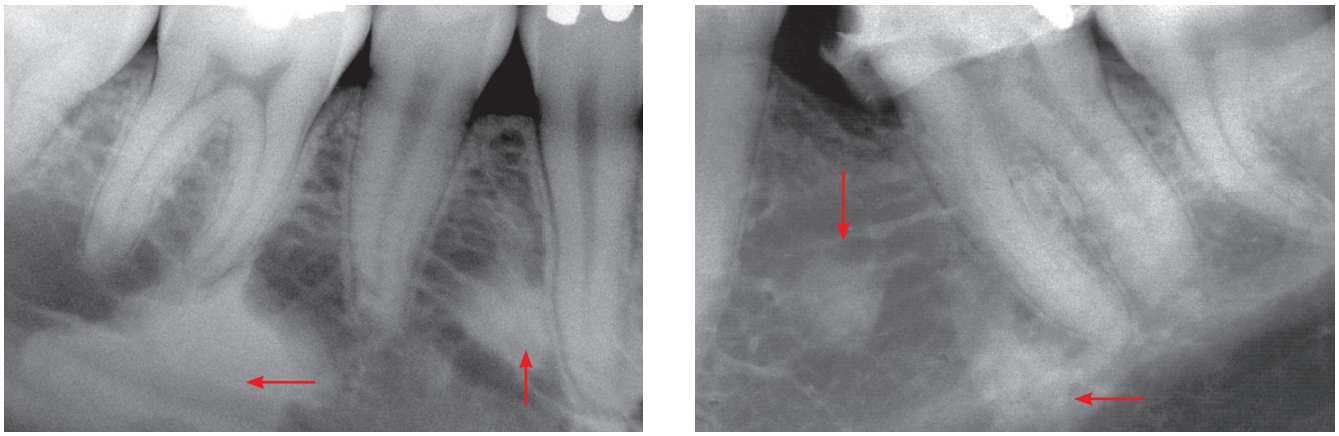


Figure 3 - Idiopathic Osteosclerosis (arrows) without cause-effect identification. In the past, some low intensity and long duration trauma may have happened in the area. The sclerotic areas persisted indefinitely and, very slowly, can disappear with constant and normal bone remodeling.

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statements. In many cases, the cause may be related to primary teeth with inter-radicular lesions, occlusal trauma, chronic periapical diseases, repair of bone surgery procedures that were used as autogenous bone grafting and other procedures.

The bone in an Idiopathic Osteosclerosis has structure and normal function, the difference is in the higher trabecular density. In this region teeth can be moved, osseointegrating implants and mini implants can be applied without further consequences, as long as in the region there is no infectious microbial component.

SPECIFIC CARE FOR TOOTH MOVEMENT INTO SCLEROTIC AREAS

In idiopathic osteosclerosis, the cells and other bone structures are normal. Remodeling is done normally, but takes longer, because as the trabeculae are thicker and the medullary spaces are very small, there are fewer surfaces exposed to the activity of the clasts. The more cancellous is the bone; more available surfaces are suitable for the action of the cells in bone remodeling units, especially the clasts, by allowing a faster process. In areas of Idiopathic Osteosclerosis, remodeling or turnover happens in a slower pace, as occurs in the cortex when compared with the trabecular bone.

The forces in orthodontic movement induce a bone deflection, a structural deformation that absorbs a small part of the applied force, reducing the effects on the periodontal ligament. Specifically, in the periodontal ligament, most of the applied forces are imposed on the vessels and cells, with stress, releasing and increasing the concentration of mediators required for the alveolar bone resorption for tooth movement to occur.

The integrity of the periodontal ligament and their cells is very important for tooth movement to occur. If the force completely blocks the lumen of blood vessels, anoxia causes the cells to migrate or die, leaving at the site only the hyaline extracellular matrix and the movement does not occur efficiently and significant root resorption, due to the death of cementoblasts, can still happen.[1]

In the orthodontic movement, the greater or more concentrated is the force, the more likely it will not be efficient, because it will promote an absence of cells by their escape into the surrounding areas and/or their death. If this happens, the segment of the periodontal ligament will be amorphous and eosinophilic, occupied only by hyalinized extracellular matrix. With intense or concentrated forces tooth movement does not occur. If it occurs, it can only minimally be moved, but taking longer and at the expense of many symptoms and root resorption.[1]

For an orthodontic movement to be effective, it requires a biologically viable association, with preserved cells and tissue components. The orthodontic movement represents an event of biological and not physical nature; forces are the initial inducing agents of biological processes. When applying great or concentrated forces cellular life on the region is prevented and orthodontic movement to occur requires cells and vessels functioning normally.

When you apply an orthodontic force in teeth inserted or neighboring areas of thicker bone, the deflection is insignificant or absent.[1] The force applied on the tooth tends to focus on its full potential on the periodontal ligament, which contains the cementoblasts, which protect the integrity of root. Hyalinization areas may be established by leakage and cell death, despite conventional orthodontic forces applied. Without the deflection due to the higher bone density, normal and conventional forces become dangerous to the tissue ligament during tooth movement along areas of idiopathic osteosclerosis. Any force applied to teeth in dense areas, directly affect the periodontal ligament.

In cases needing to move a teeth through denser areas such as idiopathic osteosclerosis bone type, the ideal would be to use smaller forces than those conventionally employed, compensating part of the force that would be dissipated by the adjacent bone deflection. By analogy, reducing the force corresponds to a discount, or compensation, because the bone deflection does not happen due to the higher density on site. In doing so, surprisingly a normal and even faster movement will occur, even in a denser area.

The same reasoning on force application in the orthodontic movement having part of their intensity dissipated by bone structures around the teeth can be extrapolated to the cortical bone (Fig 4).

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By moving teeth along cortical bone, if there is no special care to reduce force intensity, tooth displacement may occur, but the risk of further destruction of cementoblasts increases considerably, with the possibility of having more severe root resorption.[1] In short, when moving teeth along cortical bone care should be taken to reduce the intensity of the forces, because the bone deflection will be much smaller, increasing the effects on the periodontal ligament and its structures.

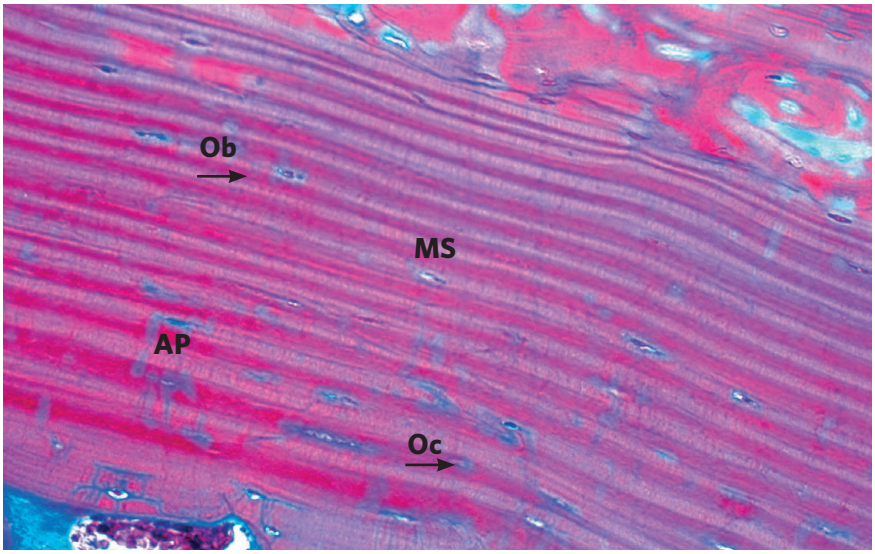


Figure 4 - Bone cortex constituted by various well defined layers of lamelar aposition (AP), which, in between, osteocytes can be noted. Ob=osteoblasts; Oc= osteoclasts. (HE, 25x).

Some questions could be answered in future works:

1) What is the prevalence of root resorption in teeth that were moved into areas of denser bone, as Idiopathic Osteosclerosis, with and without the care mentioned earlier?
2) What is the prevalence of root resorption in teeth that were orthodontically moved along denser cortical bone, or even teeth that were anchored in the cortex?
3) Would differences in the frequency of root resorption in some types of teeth be related to bone density and the thickness of the cortical bone, features which vary in the different segments of the jaws?

FINAL THOUGHTS

Idiopathic osteosclerosis has no detectable cause-effect relationship, but may have been an earlier a Chronic Focal Sclerosing Osteitis, whose cause has been eliminated, such as a chronic periapical lesion, periodontal disease, pericoronaritis and occlusal trauma. A considerable number of induced sclerotic areas takes years or no longer return to normal, remaining indefinitely as part of the trabecular region, being diagnosed as idiopathic osteosclerosis.

While moving the teeth in these areas force intensity should be reduced because they do not exhibit any bone deflection and the same intensity will be applied on the periodontal ligament. The use of conventional forces in these cases can induce hyalinization areas and death of cementoblasts followed by root resorption, besides preventing an efficient tooth movement, which will become slower and symptomatic.

The same extrapolation can be done for tooth movement along cortical bone: They have insignificant or even no deflection, thus it may increase the risk of root resorption, including when teeth anchorage is performed in these structures. Further studies may detect more accurately the prevalence of root resorption, symptoms and efficiency of orthodontic movement when in dense areas of trabecular and/or cortical bone.

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Evaluation of shear bond strength of different treatments of ceramic bracket surfaces

Patrícia Helou Ramos Andrade[1], Rogério Vieira Reges[2], Marcos Augusto Lenza[3]

Objective: To evaluate the bonding strength of the interface ceramic bracket and composite resin restoration, using four types of treatment on the base of the bracket.

Methods: 48 photoactivated resin disc were used (Filtek™ Z250) contained in specimens and divided into 4 groups of 12 specimens for each group according to the type of treatment performed on the bases of the brackets. Once bonded the brackets, the specimens were subjected to shear stress carried out in a universal testing machine (MTS: 810 Material Test System) calibrated with a fixed speed of 0.5 mm / minute. The values obtained were recorded and compared by means of appropriate statistical tests (analysis of variance and then Tukey's test).

Results and conclusions: The surfaces of ceramic brackets conditioned with 10% hydrofluoric acid for 1 minute, followed by aluminum oxide blasting, 50μ, after silane application and adhesive application, was considered the best method to prepare of surfaces prior to ceramic brackets orthodontic esthetic bonding..

Keywords: Ceramic bracket. Composite. Shear.

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How to cite this article: Andrade PHR, Reges RV, Lenza MA. Evaluation of shear bond strength of different treatments of ceramic bracket surfaces. Dental Press J Orthod. 2012 July-Aug;17(4):17-8.

Submitted: August 6, 2008 - **Revised and accepted**: January 26, 2009

» The authors report no commercial, proprietary or financial interest in the products or companies described in this article.

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Editor's summary

Corrective Orthodontics in the current aspect, presents itself with a variety of materials and techniques that aims to streamline the treatment seeking functionality and esthetics. One of the challenges the professional faces, in terms of technique and material, is the union of esthetic orthodontic attachments to teeth with composite resin or ceramic restorations. Thus, the authors' proposal in the present work was to evaluate the shear bond strength of ceramic brackets bonded to composite resin surface after different treatments carried out at the base of the brackets before bonding. For this, it was made 48 photoactivated composite discs, 10 x 5 mm, which were included in metal tubes in a centralized manner. Prior to the bonding of ceramic brackets, the specimens were divided into 4 groups (n = 12): Group I – surfaces of the brackets conditioned with hydrofluoric acid (HFL) to 10% for 1 minute, rinsed and dried for 30 seconds with air jets; Group II – surfaces of the brackets blasted with aluminum oxide for 10 seconds; Group III – surfaces conditionated with hydrofluoric acid (HFL) to 10% for 1 minute, rinsed for 30 seconds and dried with oil-free air jets. Then, they undergone blastings with aluminum oxide for 10 seconds and Group IV – in the surfaces were made prophylaxis with a brush and pumice, rinsed for 30 seconds and dried with jets of oil-free air (control group). Continuing with the surface treatment on Groups I, II and III, it was applied dry silane with air jets for 15 seconds followed by application of two layers of primer, thus removing excess with absorbent paper. The surfaces of the composite resin discs were performed conditioning with 37% phosphoric acid for 30 seconds followed by rinsing, drying and primer application. After performing all the different types of surface treatments, the brackets were bonded with Transbond™ XT. Following, the entire sample was subjected to a shear test in a universal testing machine MTS: Material Test System 810 (Fig 1). The results showed that the highest strength values were achieved by the group III which presented no statistical differences with the group II ($p > 0.05$). Group IV presented the lowest values being statistically different from the others ($p<0.05$). The authors conclude with the completion of this work that the surfaces of ceramic brackets conditioned with 10% of hydrofluoric acid for 1 minute, followed by blasting with aluminum oxide size 50µm, after application of silane and primer application, was considered the best method for preparing ceramic brackets surfaces prior to orthodontic bonding.



Figure 1 - **A**) universal testing machine MTS: 810 Material Test System. **B**) Moments before the rupture of the adhesive bond of the ceramic/composite/composite interface.

Use of chondroitin sulphate and glucosamine sulphate in degenerative changes in TMJ: A systematic review

Eduardo Machado[1], Patricia Machado[2], Paulo Afonso Cunali[3]

Introduction: Degenerative changes in Temporomandibular Joint (TMJ) have increased in prevalence and severity over the years. Within this context, it´s necessary to obtain safe and effective therapies for control and management of the patient in cases of osteoarthritis and osteoarthrosis of the TMJ. Therapeutic options range from intra-articular infiltration protocols, occlusal splints, pharmacological therapies and physiotherapy and educational measures. The alternative treatment with structure-modifying agents, like as chondroitin and glucosamine sulfates, showed promising results, and especially safety. Thus, through a systematic literature review, this study aimed to analyze and discuss effectiveness and safety of chondroitin and glucosamine in degenerative changes of the TMJ.

Methods: Survey in research bases: MEDLINE, Cochrane, EMBASE, Pubmed, Lilacs and BBO, between the years of 1966 and January 2009, with focus in randomized clinical trial (RCTs) and quasi-randomized clinical trials, systematic reviews and meta-analysis.

Results: After application of the inclusion criteria was reached 2 articles, both randomized controlled double-blind clinical trials, which evaluated the effectiveness of chondroitin and glucosamine in degenerative changes of the TMJ.

Conclusions: There is necessary further RCT, with representative samples and long follow-up time, to obtainment cause-effect relationships more precise and to achieve an objective and effective protocol involving chondroitin and glucosamine in cases of degenerative changes of the TMJ.

Keywords: Chondroitin. Glucosamine. Temporomandibular joint. Temporomandibular disorder. Osteoarthrosis. Osteoarthritis.

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How to cite this article: Machado E, Machado P, Cunali PA. Use of chondroitin sulphate and glucosamine sulphate in degenerative changes in TMJ: A systematic review. Dental Press J Orthod. 2012 July-Aug;17(4):19-20.

Submitted: January 19, 2009 - **Revised and accepted**: August 16, 2009

» The authors report no commercial, proprietary or financial interest in the products or companies described in this article.

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Editor's summary

Currently, musculoskeletal diseases represent a great public health problem due to the longevity observed in the world population. Within this context, osteoarthrosis is a frequent and important situation of morbidity and disability, especially in the second half of life, increasingly affecting younger patients. Osteoarthrosis and osteoarthritis are degenerative diseases that affects joint tissues, causing damage to the articular cartilage, generating painful symptoms and functional limitations. Associated with this condition, there are few therapies with effective results. Therapeutic modalities for the control and management of osteoarthrosis are diverse and are related to disease stage, involving patient education, exercise and medication (analgesics and non steroidal anti inflammatory drugs - NSAIDs). Eventually, also the orthopedic surgeries are indicated. In relation to drug therapies, specifically, the treatment is divided into symptoms modifying drugs and structure modifying substances. Symptoms modifying drugs have its performance related to improvement in pain and function, while the structure modifying substances have its indication associated with structural changes in the joint spaces. Thus, the aim of this systematic literature review is the discussion based on scientific evidences regarding to the effectiveness of nutraceuticals, such as glucosamine and chondroitin sulfates, in the treatment of degenerative changes of the TMJ.

After applying the inclusion criteria, it was obtained 2 double-blind randomized clinical trials that evaluated the effectiveness of chondroitin and glucosamine sulfates in the treatment of degenerative changes of the TMJ, as shown in Table 1. The Kappa index of agreement between reviewers was 1.00, with no need to use a third reviewer.

Glucosamine is one of the main pillars of the structural matrix of connective tissue of joints, besides being a substrate for the synthesis of glycosaminoglycans, stimulating synthesis and inhibiting its degradation. It also has a protective effect in the body against oxidative damage. On the other hand, Chondroitin is a glycosaminoglycan found in articular cartilage proteoglycans. Both compounds are synthesized naturally in each joint. The exact mechanism of action of chondroitin sulfate and glucosamine sulfate in the treatment of osteoarthritis has not been fully elucidated. These substances act synergistically to stimulate glycosaminoglycan synthesis in chondrocytes. Also, combined with the antiprotease action of chondroitin sulfate, provides greater efficacy in delaying the degenerative process. Glucosamine has little effect on the inhibition of aggrecanase and collagenase, enzymes responsible for cartilage degradation. The studies included in this systematic review demonstrate that chondroitin and glucosamine showed better results than NSAIDs and placebo in the treatment of internal changes of the TMJ. The use of chondroitin and glucosamine in other joints of the human body in cases of osteoarthrosis/osteoarthritis, such as knees and hips, demonstrate positive results using structure-modifying agents in reducing pain and improving function, being dietary supplements safe and with little or no adverse effects. The systematic literature review showed that are necessary further randomized clinical trials, based on represen tative samples and long follow-up, to assess the effectiveness and safety of proposed treatments for the control and management of degenerative changes of the TMJ.

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Table 1 - Characteristics of included studies.

Authors	Study design	Evaluated substance	Sample Size (n)	Evaluation period	Results
Nguyen et al[1]	RCT double-blind and controlled	Chondroitin (400 mg 3 x daily) and glucosamine (500 mg 3 x daily) associated	14 active tt 20 control	12 weeks in patients with internal changes in the TMJ	Improvement in relation to the pain, tenderness in TMJ and joint sounds
Thie et al[2]	RCT double-blind and controlled	Glucosamine (500 mg 3 x daily) Ibuprofen (400 mg 3 x daily)	21 tt Glucosamine 18 tt Ibuprofen	90 days in patients with osteoarthritis in the TMJ	Glucosamine more effective in decreasing pain than Ibuprofen

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Knoop hardness of enamel and shear bond strength of brackets bonded with composite resin with and without fluoride

Silvia Amélia Scudeler Vedovello[1], Marcelo Grigoletto[2], Mário Vedovello Filho[1], Heloísa Cristina Valdrighi[1], Mayury Kuramae[1]

Objective: The aim of this study was to evaluate the Knoop hardness of enamel, shear bond strength and failure pattern (adhesive, bracket/resin interface and mixed) after bonding and debonding brackets, using resin composite with fluoride (Ortho Lite Cure, Ortho Source®) and without fluoride (Orthobond, Morelli®).

Methods: Fragments (6 mm x 6 mm) of 40 bovine incisor crowns were embedded in acrylic self-polymerizing resin. The Knoop hardness measurements were performed before and after bonding metal brackets. The specimens were divided into 2 groups, according to composite resin: with fluoride (Ortho Lite Cure, Ortho Source®) and without fluoride (Orthobond, Morelli®). After bonding, the specimens were submitted to demineralization and remineralization cycling for 14 days. Shear bond strength testing was performed in a universal test machine (EMIC), at 5 mm/min crosshead speed.

Results: There was no significant difference in shear bond strength between groups 1 and 2. After demineralization and remineralization procedures, the specimens bonded with Ortho Lite Cure showed higher Knoop hardness than Orthobond. For both groups there was predominance of failure at bracket/resin interface.

Conclusion: specimens bonded with fluoride resin composite showed higher microhardness after de-re cycling than those bonded with resin composite without fluoride, although no difference in shear bond strength was found.

Keywords: Composite resins. Orthodontic brackets. Hardness. Shear strength.

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How to cite this article: Vedovello SAS, Grigoletto M, Vedovello Filho M, Valdrighi HC, Kuramae M. Knoop hardness of enamel and shear bond strength of brackets bonded with composite resin with and without fluoride. Dental Press J Orthod. 2012 July-Aug;17(4):21-2.

Submitted: May 12, 2009 - **Revised and accepted**: April 12, 2010

» The authors report no commercial, proprietary or financial interest in the products or companies described in this article.

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Editor's summary

To reduce the incidence of caries around orthodontic brackets, materials with the ability of fluoride release were introduced, as glass ionomer cements and composite resins. With the production of these materials it is necessary to evaluate their physical-chemical behavior. Thus the authors' proposal regarding the present study was to evaluate the knoop hardness of enamel, shear strength and failure pattern (adhesive, interface bracket / resin, and mixed) after bonding and debonding of orthodontic brackets using composite resin with fluoride and without fluorine. Forty bovine incisors crowns were used and were sectioned with two-sided diamond discs under water cooling, to obtain fragments of 6 mm x 6 mm. These fragments were embedded in PVC® cylinders with acrylic self-polymerizing resin. After obtaining all the specimens, they were separated into two groups according to the bonding material used (n = 20): Group I - bonded with the Orthobond (Morelli) composite, without fluoride; and Group II – bonded with the Lite Cure Ortho (Ortho Source) composite resin with fluoride. After bonding, the specimens underwent a demineralization and remineralization cycle for 14 days and subjected to the test of shear strength in a universal testing machine EMIC, at 0.5 mm / min crosshead speed. After test shear strength the samples were analyzed with a stereomicroscope (CQA, EK3ST model), at 20X magnification, to determine the failure pattern. Knoop hardness was done before and after bonding of metal brackets (Fig 1). The data of the microhardness and shear were submitted to ANOVA and Tukey test ($p<0.05$). The findings demonstrated that there was no statistically significant difference for initial hardness values between the groups ($p>0.05$). However, the specimens that received fluoride composite (Ortho Lite Cure) had significantly higher final microhardness compared to those bonded with composite without fluoride (Orthobond) ($p<0.05$). The analysis indicates that a significant reduction in hardness values happened after the procedures of demineralization and remineralization, both in the specimens of Group I and II. The shear test showed that there was no statistically significant difference between samples bonded with Ortho Lite Cure and Orthobond ($p>0.05$). The analysis of the failure pattern showed that the specimens of group I and II had a predominance of failure at the interface composite / bracket (55%, 50%). Thus the authors could conclude that there was no significant difference in shear bond strength between Orthobond and Ortho Lite Cure. The sample bonded with composite resin with fluoride (Ortho Lite Cure) had higher microhardness after demineralization and remineralization processes when compared to the sample bonded with composite resin without fluoride (Orthobond), and for both groups there was a predominance of failures at composite / bracket interface.

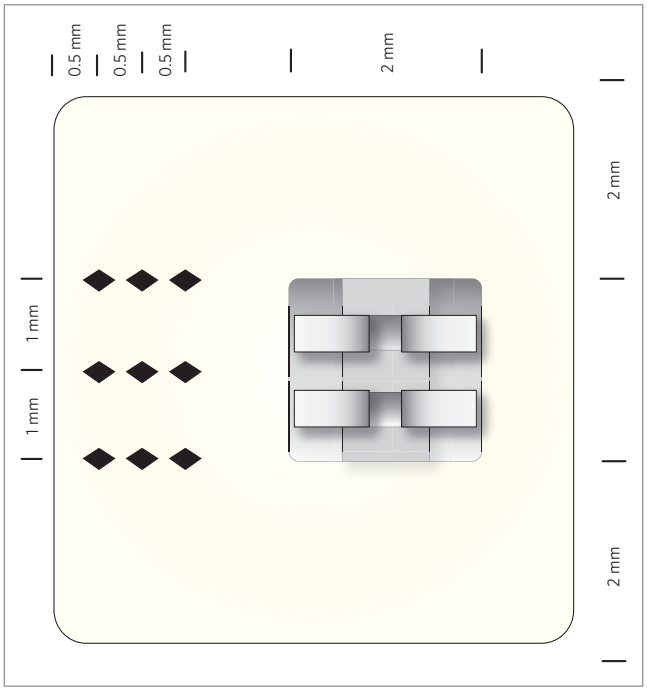


Figure 1 - Diagrammatic drawing of the Knopp Hardness readout region.

Assessment of shear bond strength of brackets bonded by direct and indirect techniques: An *in vitro* study

Roberto Hideo Shimizu[1], Karlos Giovani Grando[2], Isabela Almeida Shimizu[3], Augusto Ricardo Andriguetto[3], Ana Cláudia Moreira Melo[3], Eduardo Leão Witters[2]

Objective: This in vitro study was designed to evaluate the shear bond strength (SBS) of orthodontic metal brackets bonded by direct and indirect techniques.

Methods: Thirty healthy human maxillary premolar teeth were used. The teeth were divided into three groups of 10 teeth each: Group I - Indirect bonding with Sondhi™ Rapid-Set system (3M/Unitek), Group II - Indirect bonding with Transbond™ XT adhesive system (3M/Unitek) and Group III - Direct bonding with Transbond™ XT Adhesive system (3M/Unitek). After bonding and obtaining the specimens for the study, the specimens were subjected to SBS testing in a universal testing machine (Emic, model DL – 500). The Kolmogorov-Smirnov test was applied to ascertain that the data had a normal distribution and the Bartlett test to check whether there was homogeneity of variance. One-factor analysis of variance was performed and, subsequently, Tukey's test for paired means. A 5% significance level was adopted.

Results: The results of Group I were 67.6 (N) and 5.9 (MPa), Group II, 68.9 (N) and 6.1 (MPa) and Group III (control) 92.5 (N) and 8.1 (MPa).

Conclusion: It can therefore be concluded that the means for Group III were significantly higher compared with groups I and II in both Newton (N) and Mega Pascal (MPa) values. The means attained by the indirect bonding technique used in Groups I and II, however, exhibited no statistically significant differences.

Key-words: Dental bonding. Dental debonding. Shear bond strength. Corrective Orthodontics.

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How to cite this article: Shimizu RH, Grando KG, Shimizu IA, Andriguetto AR, Melo ACM, Witters EL. Assessment of shear bond strength of brackets bonded by direct and indirect techniques: An in vitro study. Dental Press J Orthod. 2012 July-Aug;17(4):23-4.

Submitted: November 16, 2009 - **Revised and accepted**: June 20, 2011

» The authors report no commercial, proprietary or financial interest in the products or companies described in this article.

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Editor's summary

Indirect bonding in Orthodontics presents some advantages compared to direct bonding of brackets, including greater precision, less need for accessory repositioning, reduced chair time and reduced patient discomfort. In contrast, this technique also presents some disadvantages, such as laboratory work time, higher cost, greater number of stages, and the interface between the bonding adhesive and the primer applied to the tooth, which may impair adhesion. The indirect bonding would have a similar resistance compared to the classic direct bonding? The objective of the authors was comparing the shear-bond strength of brackets in 3 groups of 10 teeth:

» Group I: Indirect bonding using Sondhi™ Rapid-Set system (3M/Unitek).

» Group II: Indirect bonding using Transbond™ XT adhesive system (3M/Unitek).

» Group III: Direct bonding using Transbond XT™ adhesive system (3M/Unitek).

Once the bracket was bonded to the tooth an elastic modulus was attached to the ASTS orthodontic wire. Then, the PVC pipes were filled with colorless acrylic resin (JET) as far as the upper edge. The samples were then subjected to SBS tests in a universal testing machine (EMIC brand, model DL-500, with a speed of 0.5 mm/min with 1kN (100 kgf) capacity, reading resolution of 0.1N (10gf), using recommended parameters for testing within a range between 20 and 1000 N. The chisel type working tip (developed for this purpose by the ODEME Company) was positioned in the occluso-gingival direction in contact with the bracket, between the tie-wing and the base, flush with the base (Fig 2). The breaking loads were measured in Newtons (N). The results are shown in Table 2 and indicated that the control group (direct bonding) had an increased shear-bond strength compared to the indirect bonding groups. Based on the present study, there was no need for using a primer especially designed for indirect bonding since the primer provided with the conventional Transbond™ XT Adhesive system offered an SBS value that was similar to that observed with the Sondhi™ Rapid-Set system. The authors considered that both direct and indirect bonding techniques can be considered satisfactory and similar to each other,[1,2,23] since shear bond strength values were found to be above the minimum recommended by the literature for clinical use, which validates both bracket bonding techniques.

Table 1 - Means and standard deviations (SD) of force in Newtons (N) and stress (MPa) showing force exerted between bracket and enamel when bonding performed using three different techniques.

	Values in Newtons (N)			Values in Mega Pascal (MPa)		
Techniques	Control (direct technique)	Sondhi Rapid-Set System	Transbond XT System	Control (direct technique)	Sondhi Rapid-Set System	Transbond XT System
Mean ± SD	92.5 ± 19.2	67.6 ± 25.6	68.9 ± 29.9	8.1 ± 1.7	5.9 ± 2.3	6.1 ± 2.6

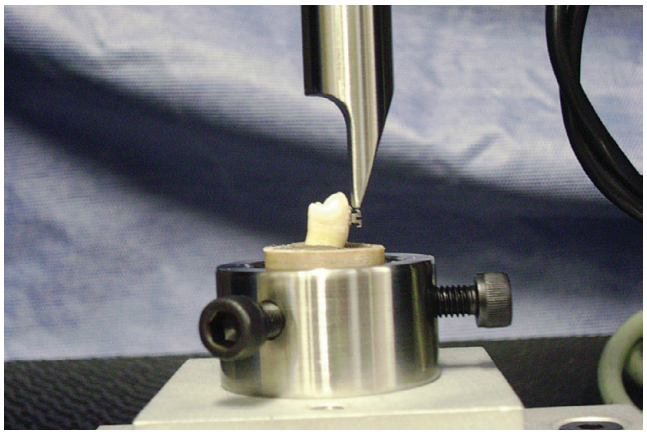


Figure 1 - Test system fitted and ready for shear bond test.

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Maxillary constriction: Are there differences between anterior and posterior regions?

Regina Helena Lourenço Belluzzo[1], Kurt Faltin Junior[2], Cícero Ermínio Lascala[3], Lucas Bacci Renno Vianna[4]

Objective: To evaluate the transverse atresia of the maxilla in both anterior and posterior regions, using Korkhaus Analysis and to check whether there were any statistically significant differences within its values.

Method: The sample comprised 341 study models. The study models were randomly selected from previous cases, without gender, age and malocclusion restrictions. The models were submitted to Korkhaus Analysis. Data from these models were subjected to statistical analyzes in order to evaluate differences in anterior and posterior regions.

Results: The transverse discrepancies were statistically significant ($p<0.001$) with a greater atresia in the anterior region, mean -2,84 mm.

Conclusion: The results showed that the differential diagnosis is very important and the treatment plan may be adapted to specific therapy focusing in a greater expansion in the anterior region.

Keywords: Maxilla. Dental casts. Treatment results.

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How to cite this article: Belluzzo RHL, Faltin Junior K, Lascala CE, Vianna LBR. Maxillary constriction: Are there differences between anterior and posterior regions? Dental Press J Orthod. 2012 July-Aug;17(4):25-6.

Submitted: March 14, 2009 - **Revised and accepted**: February 11, 2010

» The authors report no commercial, proprietary or financial interest in the products or companies described in this article.

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Editor's summary

The maxillary deficiency in the transverse plane is called maxillary constriction. The main etiologic factors of this deficiency are mouth breathing, harmful habits, like thumb sucking and / or pacifiers, speech dysfunction and infantile swallowing. The maxillary constriction affects most of our orthodontic patients and is one of the most prevalent malocclusions in orthodontic practice. The aim of this study was to determine whether maxillary constriction is different in anterior and posterior region in a Brazilian population.

The study sample consisted of 341 initial orthodontic study models from a private practice. These were randomly selected from number 1,500 to number 2,100, with no restriction in relation to malocclusion, age and gender. The Korkhaus analysis[1] was used in each cast models for evaluating the transversal discrepancy between the maxilla and the mandible in the anterior and posterior regions (Fig 1). The interpretations of Korkhaus analysis perform the subtraction of the maxillary value (anterior and posterior) with the mandible value. When the value is negative, there is a maxillary constriction; when the value is positive, the maxilla is greater than the mandible or there is a mandible constriction. When the value corresponds to zero, there is a normal transversal relations between the upper and the lower arches. Anterior constriction was considered when the values of the difference between the anterior and the posterior regions showed more than 2 mm (negative value). Equivalent constriction was considered when both values (anterior and posterior) were equal or their difference lower than -2.0 mm.

According to the methods used, 231 patients were considered as "equivalent constriction" and 110 patients were considered as "anterior constriction". The conclusion was that 32.3% of the evaluated patients presented with a greater atresia in the anterior region.

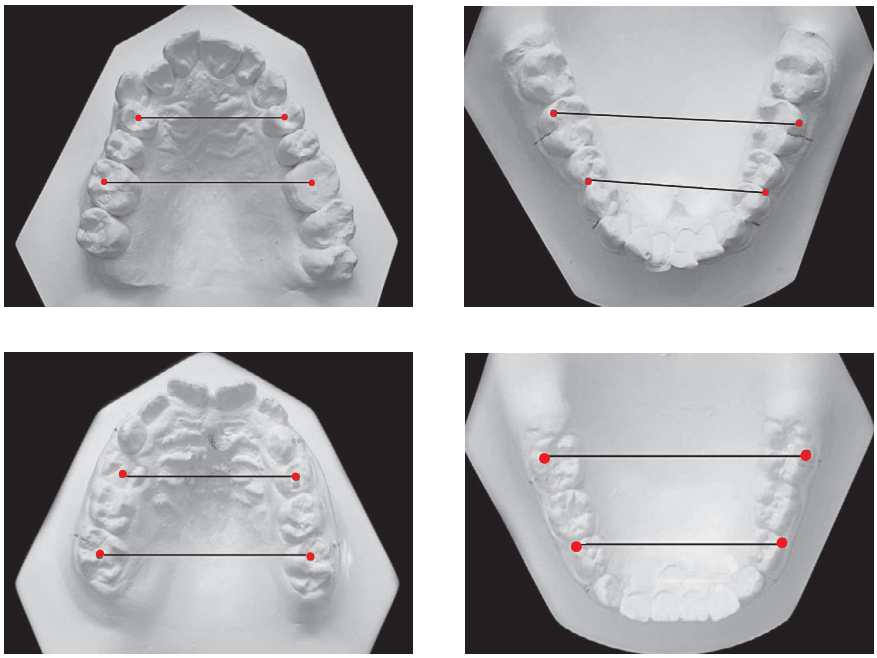


Figure 1 - Occlusal view of the casts, with lines representing the width measurements in the mixed and permanent dentition.

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Orthodontic cements: Immediate protection and fluoride release

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The objective of the authors was to evaluate fluoride release of 3 glass ionomer cements with immediate protection of fluoride varnish (Cavitine, SS White), divided into 3 groups: Group M (Meron, VOCO), Group V (Vidrion C, SS White) and Group KC (Ketac-Cem, 3M ESPE). Fluoride release was measured during 60 days by means of an ion-selective electrode connected to an ion analyzer. After 4 weeks, the test specimens were exposed to a solution of 0221% sodium fluoride (1000 ppm of fluoride). Results showed that the cements reached a maximum peak of fluoride release in a period of 24h. There was a statistically significant difference between the amount of fluoride released after the applications of fluoride among the groups from the 31st to 60th day (p> 0.05). The Vidrion C and Meron cements showed better performance to uptake and release fluoride when compared with Ketac-Cem cement.

Keywords: Glass ionomer cement. Fluoride release. Varnish.

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How to cite this article: Santos RL, Pithon MM, Leonardo JBP, Oberosler ELC, Vaitsman DS, Ruellas ACO. Orthodontic cements: Immediate protection and fluoride release. Dental Press J Orthod. 2012 July-Aug;17(4):27-8.

Submitted: August 21, 2008 - **Revised and accepted**: November 24, 2008

» The authors report no commercial, proprietary or financial interest in the products or companies described in this article.

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Editor's Summary

The glass ionomer cements (GICs) have the properties of fluoride release and chemical adhesion to enamel, which makes it the material of choice for cementation of orthodontic bands. Additionally, the GICs work as true deposits of fluoride in the oral cavity, absorbing the available fluoride in the oral environment and releasing it posteriorly, thus prolonging its anticariogenic effect. This becomes very important in orthodontic patients undergoing long-term treatments, especially those at high risk for dental caries. Given the doubts about the actual fluoride release by GICs exposed to recharge at intermittent intervals, the purpose of this study involved evaluating the fluoride release of conventional GICs before and after its recharging after 28, 30, 31 and 32 days, during a total of 60 days trial. There were made ten samples of three different brands of conventional GICs: Meron (VOCO, Germany), Vidrion C (S.S. White, Brazil) and Ketac Cem™ (3M ESPE, United States). After application of fluoride varnish, the specimens were kept in a humidifier at 37° C for 30 minutes. Then, the samples were immersed in deionized water, which was changed every 24 hours. The fluoride concentrations were measured by an ion analyzer at 1 hour and 2, 3, 7, 14, 21 and 28 days after the initial setting reaction. After 28 days, the samples were rinsed and subjected to a 0.221% sodium fluoride solution (1000 ppm fluoride) for 5 minutes. New refills of fluoride were made on days 30, 31 and 32, being the fluoride release assessed from day 29 to 33, and on days 45 and 60. The amount of fluoride released was compared between the three trademarks using the Kruskal-Wallis and Mann-Whitney test ($p<0.05$). It was found that all cements showed the same behavior prior to the first fluoride recharge, with a greater fluoride release 24 hours after the reaction of initial setting and a decrease to the seventh day. There was greater release of fluoride for cements Vidrion C and Meron. Interestingly, both GICs (Meron and Vidrion C) continued this behavior after refills of fluoride, suggesting that probably, GICs that initially released more fluoride have a greater ability to recharge afterwards.

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Optimization of orthodontic treatment using the Centrex System to retract anterior teeth

José Kleber Soares de Meireles[1], Weber Ursi[2]

Introduction: In the end of 90's the adoption of mini-implants as Anchorage allowed a paradigm change influencing even the way of thinking orthodontic mechanics. The overlapping of the specialties of Orthodontics and Implantology started with orthodontic preparations for prosthetic implants insertion, aroused with the use of palatal implants and late with the introduction of mini-implants. The improvement of mini-implants insertion technique with the appearing of self-drilling screws has allowed orthodontists to plan and to place this precious Anchorage piece. Taking into account the versatility of positioning of these screws it was developed a concept that allows the construction of force action lines aiming at optimize the planning and predictability of orthodontic motion.

Objective: To present some clinical results treatments conduct using Centrex System of orthodontic treatment, approximating the force line action of resistance center of units to be moved. The traced way to its development, previously treated in this journal, will be detailed for better understanding of its functioning.

Keywords: Orthodontic anchorage. Dental mini implants. Center of resistance.

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

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How to cite this article: Meireles JKS, Ursi W. Optimization of orthodontic treatment using the Centrex System to retract anterior teeth. Dental Press J Orthod. 2012 July-Aug;17(4):29-44.

Submitted: September 15, 2008 - **Revised and accepted:** March 09, 2009

» The authors report no commercial, proprietary or financial interest in the products or companies described in this article.

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INTRODUCTION

The use of prosthetic implants in orthodontic planning requires from Implantology and Orthodontic professionals a varied knowledge. As in cases that are referred by implantodontists for an orthodontic preparation prior implants placement, as in cases referred by orthodontists for the insertion of osseointegrated implants that will work as anchorage, a great interaction is demanded between professionals involved, as well as a minimal knowledge of the resources of another specialty, at least enough to discuss the needs and possibilities involved in the case. In the first case, the mastery of orthodontic set up preparation allows the correct planning of implant positioning without the risk of making these implants prevent posterior tooth movement. In the second case, the implant type choice, the region to receive the implant, the healing period prior to the application of orthodontic force and the magnitude of that force, they are all information that should be shared between the two specialties.

In the case of implants used only for anchorage, the location choice, size and even the type of head of the implant are defined by the orthodontist. These are always orthodontic options, since they are directly and inseparably linked to the treatment planning and to the chosen mechanics. Thus, it is natural that the orthodontist keeps taking for himself the responsibility of placing mini-implants in his clinical practice. This transition has been occurring gradually.

When the first mini-implants were introduced to the medical armamentarium, initially with the palatal implants,[28] their application was almost restricted to the use of indirect orthodontic load, with a transpalatal arch connecting upper molars to the implant. That was beyond question an advance for a more efficient anchorage. Nevertheless, disadvantages as the flexibility of the arch, associated with the maintenance of traditional sliding mechanics for retraction, allowed some mesialization of posterior teeth, besides not correcting the concepts of force application, which was kept away from the center of resistance of units to be moved.

The inclusion of versatile mini-implants (MI)[12] to the clinical practice allowed great and positive changes in orthodontic protocols. In the yet very recent early years of the use of these implants, possibly because the planning and insertion were performed almost exclusively by implantodontists, the placement of these small anchorage parts had high periodontal indications. Buccally inserted implants in cases of anterior teeth retraction, for example, were almost always situated in a position close to the clinical crown, always aiming to be placed in attached gingiva. Such placement, almost unalterable, required orthodontic mechanics to stay overpowered to the position of MI. It was the time of ascendency of implantology over mechanics. As the quantity and quality of inserted gingiva can vary considerably between individuals and mouth regions, in some cases reaching less than 1 mm,[26] this could impose one more challenge for MI insertion and for orthodontic practice. The implant improvement and surgical technique have lead to what we consider more correct: The MI positioning as part of orthodontic planning, aiming at mechanical optimization. This is a new path that literature has trailed[27] and has produced important changes in the way to conduct biomechanics in Orthodontics.

In a previous article[19] a proposal of orthodontic movement was presented with appliances capable of moving apically the force action line to the desired position, according to previous planning. In this paper clinical applications of these concepts discussed before will be presented. Cases involving anterior teeth retraction, will be emphasized, one of most frequent clinical situations in orthodontic practice.

Anterior teeth retraction

Upper anterior retraction (UAR) or lower (LAR) is one of most difficult clinical steps for the orthodontist, specially for the fact that it in itself some traps that, in grater or smaller magnitudes, can harm the treatment process or even make its continuation unfeasible due to an eventual excessive loss of root structure. Such occurrence is more common in upper and lower incisors during distal movement of these teeth for Class II correction or double protrusions.[24] The lack of adequate torque control during UAR tends to produce an out of control inclination movement of anterior teeth, buccally protruding the apical third of these teeth in an area of low osseous availability (Fig 1).[19] This becomes even more relevant in cases of adult patients with horizontal bone loss, since the applied force in the crown is transferred to the apices with greater magnitude, since the center of resistance of teeth, in such situations, are more apically located.

Greater force magnitude, apart from unwanted, increases apical root resorption in these teeth.[7,17,19]

Eventually if loss of inclination control occurs during retraction, in addition to the possibility of root resorption there is a tendency of excessive uprighting of the anterior teeth. Such a fact is perceived mainly, in cases of great retractions. What happens is that the force, being applied at the crown of the teeth, produces a movement of great magnitude that is greater the more apical positioned is the center of resistance of the teeth set being distalized. In view of that, such teeth tend to rotate clockwise. The excessive uprighting of these units also can result in an increase in overbite.[2]

It is not uncommon to observe in treatment planning involving upper teeth extractions for overjet correction, the blocking of distal movement of anterior teeth, due to the absence of horizontal overlap, without, however, obtaining the correction of canine relation. What is seen in these cases is a situation like the one described in Figure 2.

This loss of inclination control besides blocking UAR tends to project the apex of the anterior teeth over the maxillary buccal cortex, in this way increasing the resorption potential of these teeth.[2,24]

Figure 3 images show the difficulties usually found in overjet correction. Anterior teeth inclination in the beginning of treatment was slightly increased, however retraction magnitude, in this case assisted by indirect anchorage with the palatal implant, associated to the difficult torque control with polycarbonate brackets (even with metallic slots) made such teeth loose a lot of inclination until the end of treatment.

In order to avoid this effect, a strict anterior torque control is vital during UAR or LAR. The incorporation of active buccal torque or resistent torque should be planned to avoid such occurrence. Nevertheless, once this has happened, retraction mechanics should be interrupted until negative effects are corrected. At this point, it is necessary to include active palatal root torques to regain an adequate overjet to give continuity to the retraction movement of the anterior teeth (Fig 4).[2]

Although the reversion of the inconveniences previously mentioned is possible, there is a delay in treatment, creating an interruption point, where only the correction of errors incorporated during mechanics is corrected. It is common to think that the use of pre adjusted brackets can prevent the occurrence of these side effects. This is a huge mistake perpetuated by the idea that straight wire mechanics is simple and infallible. No mechanics or bracket have in themselves the solution for all orthodontic problems. It is important to have good sense and reasoning to know the moment to use different resources and techniques, always focusing in the best result for the patient.

As well stated by Capelozza et al:[6] "individualized treatment plan, individualized appliance and mechanics. Certainly this is to look at the future." The individualization of brackets for orthodontic movement

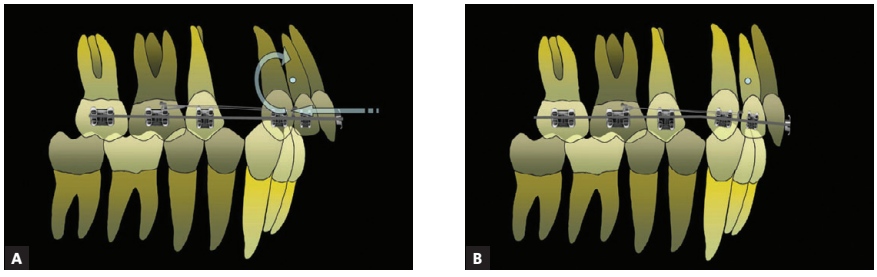


Figure 1 - Retraction of anterior teeth with loss of inclination (**A**). The crowns moving toward palate while roots are protruding buccally (**B**).

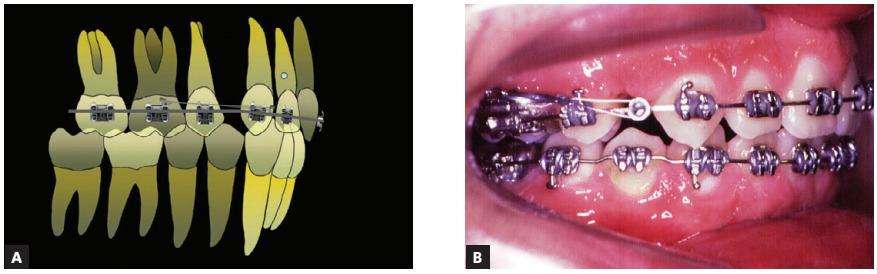


Figure 2 - The contact between upper and lower incisors occurred before the correction of canine relation (**A**). A clinical example of this situation (**B**).

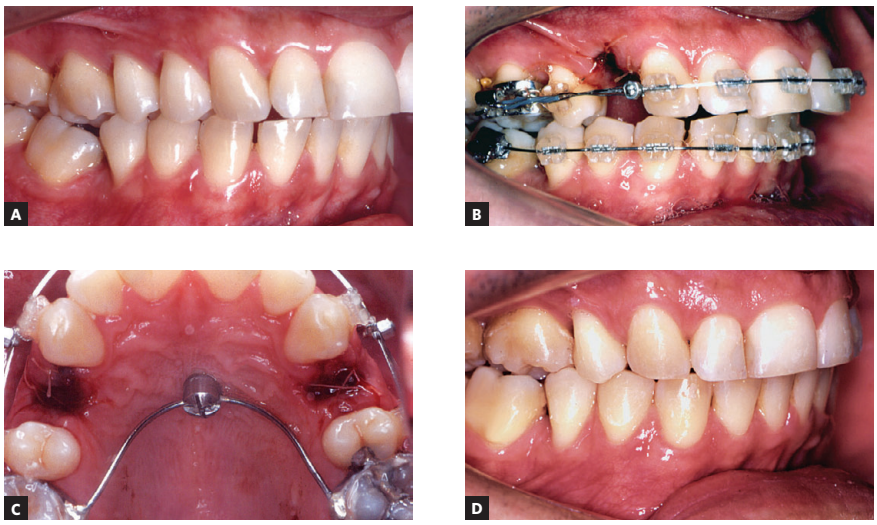


Figure 3 - Upper premolar extractions were planned for correction of increased overjet (**A**, **B**). A palatal implant was used and indirect anchorage transferring its rigidity to molars by the a transpalatal arch (**C**). At the end of retraction, anterior teeth lost much of their inclination (**D**).

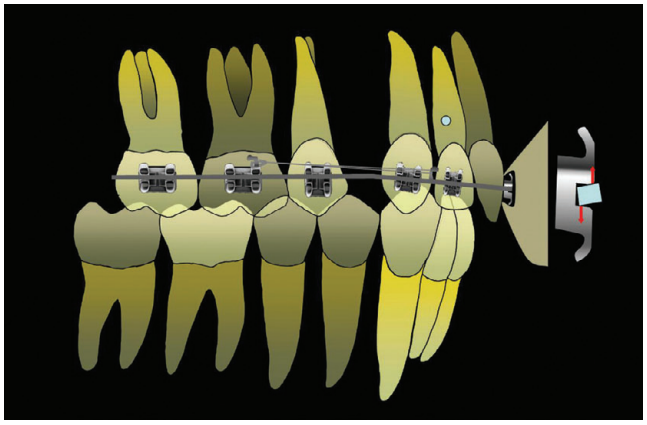


Figure 4 - Example of necessary torque for correction of upper incisors inclination.

must be thought not only in the individual types of bracket, but also in the combination with the available wires. A good example of this philosophy is the following: let's think a certain upper central incisor bracket has an inclination prescription (torque) of +12°. In the beginning of the retraction stage, if this inclination is considered appropriate and it is desired to keep it, the only way to perform it, using a wire without anterior torque, is to increase the wire caliber, approximating to the slot dimensions. In case of a slot measuring 0.022 x 0.030-in, the choice would be a 0.021 x 0.025-in wire. Filling the slot allows the full expression of the prescription, including torque, embedded in the bracket, besides the adequate inclination control during movement of the teeth. The problem is that this wire almost makes retraction by sliding impossible, since friction in the anterior region would be an impeditive factor for such tooth movement.[3,13]

On the other hand, if a 0.017 x 0.025-in wire were used, sliding would be easier. Nevertheless, such dimensions would not allow an ideal inclination control of anterior teeth, since there is a considerable

gap between wire and slot. In this case, if the aim to maintain inclination, at least the incorporation of a resistant buccal crown torque is necessary. It would be interesting that the orthodontic supplies companies make available different wire calibers for anterior and posterior regions. However, this is not the solution for all problems, as the abundance of brackets available in the market is also not the solution. As an example, the introduction of a higher inclination in individualized brackets for anterior teeth when they are under retraction has become common. This procedure tries to compensate the loss of inclination caused by the use of a lower caliber wire, as if it were a resistent torque.[2] Although correctly indicated in such situations, the use of this resource can generate excessive inclination of anterior teeth and ceased the distal movement of incisors, specially if a higher caliber wire is inserted.

Since the adequate inclination for anterior teeth is directly dependent on the facial pattern of each individual, the necessary compensation for treating Class II or III individuals is not constant, closely depending on the magnitude of the problem. Therefore, only the absolute individualization, with brackets made exclusively for each case, can grant the abolition of torque or adjustment needs in the wire-bracket management, what clearly is, at least nowadays in the Brazilian reality, commercially unfeasible. Hence, torque control by means of orthodontic wires is still necessary in any type of bracket, specially when the straight wire technique with sliding mechanics is used. In individuals presenting bone loss in the anterior region, torque control is even more critical, since the center of resistance of the teeth is further away from the crown, where the force is applied.[19] In these cases, torque magnitude should be increased to interpose the force generated by the retraction. In some situations, it is appropriate to modify the force line of action to make it closer to or even coincide, in height, to the center of resistance of teeth to be moved.[1] This concept will be present in the clinical cases illustrated in this article.

The possibility of insertion of mini-implants in different positions allows a more favorable management of orthodontic mechanics. Some papers have suggested a more apical orthodontic force of retraction, in order to optimize mechanical results[14,21] and the mechanics should be driven by this rationale.

The development of the Centrex System was based, among other factors, in the observation of side effects quoted in this paper. In order to give greater efficiency to the movement of the anterior teeth, first the stretching of the retraction hooks in the apical direction was tested, with the purpose of decreasing the moment acting on the set of incisors and canines. Nevertheless, there was yet the need to use smaller caliber wire to allow retraction with less friction.[5] The use of the Centrex System was, as will be seen below, the next step in attempting to solve, or at least minimize, this and other disadvantages of the mechanics.

It is important to point out that some plans require the adoption of a force line of action closer to the crown of the teeth, as for example in cases of excessive inclination of anterior teeth, in which the introduction of a clockwise movement is welcome. Nevertheless, even in such cases, it should be borne in mind that at some point of the retraction, the positional control of the teeth will be necessary with the use of torque.[18]

The next cases exemplify situations in which the line of force was instituted in different heights and inclinations, describing the objectives and results of such choices.

CLINICAL CASES

Case 1 (Figs 5 to 8)

Female patient, 26 years old, had a Class II, right subdivision, dental relationship as a result of the early loss of tooth 46. Facial analysis made evident a Class I pattern with labial double protrusion, being that her main complaint. The proposed treatment plan was with three extractions: two first upper premolars and the first left lower premolar, to enable upper and lower anterior retraction with decrease of double protrusion. To do this, a very powerful anchorage would be necessary. Two MI were inserted to the upper and lower dental arch, in the left quadrant, all mesially positioned near the molars and dental crowns. The retraction with the line of force coronally positioned in relation to the center of resistance of six anterior teeth required the construction of resistant anterior torques throughout the movement, aiming for a suitable mechanical control during correction of inclination and protrusion of teeth. An intrusive component was present in the upper arch, during retraction, because of the inclination of the line of force, which helped, in this case, the vertical control during distalization of anterior teeth (Fig 5 to 8).



Figure 5 - Excessive anterior dental protrusion prints its mark with the exposure of well-defined root contours.



Figure 6 - MI inserted next to crowns.



Figure 7 - End of treatment with inclination correction and the anterior protrusion.



Figure 8 - Facial profile before (**A**) and after (**B**) orthodontic correction, highlighting the "smoothing" of lip filling post-treatment.

Case 2 (Figs 9 to 12)

Female patient, 29 years old, was in treatment for approximately three years with another professional, when looked for a second opinion for resolution of increased overjet, which was being handled without extractions. The new treatment plan consisted in extractions of first two first upper premolars to provide space for the correction of the excessive overjet. Two MI were inserted bilaterally distal to the second upper premolars, at a height of 6 mm above the orthodontic wire, so, presumably, a little below the center of resistance of the six anterior teeth. Such position endorsed the construction of a line of force that produced a clockwise moment of small magnitude, allowing the correction of the inclination of the upper teeth. The use of a wire with a smaller caliber than the slot at the beginning of the retraction, in this case a wire of 0.018 x 0.025-in, contributed to the correction of incisor inclination. When the upper anterior teeth reached its proper inclination, the wire was changed to a larger caliber (0.021 x 0.025-in). The end of the retraction was done with the CS1 device, installed unilaterally in order to obtain the upper midline correction.



Figure 9 - The patient had, at the beginning of treatment, a Class II relation and very increased overjet.

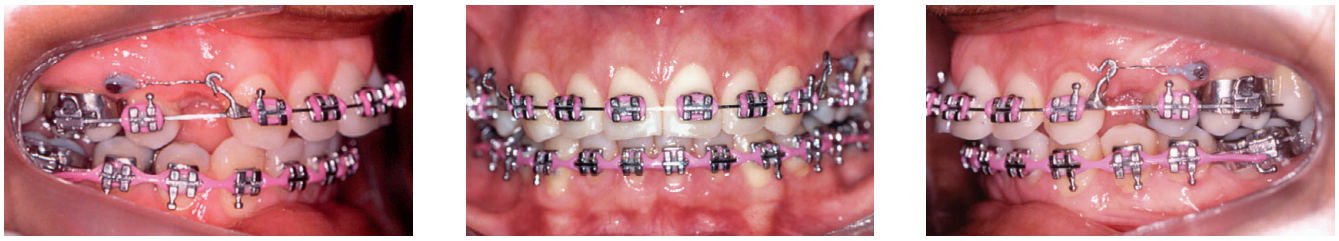


Figure 10 - Mini-implants insertion was made at approximately 6 mm in height and the hook was welded to the wire and extended apically to provide a horizontal line of action in relation to the occlusal plane, avoiding vertical effects.



Figure 11 - The completion of correction of canine relationship on the right side. On the left a steel ligature wire was kept together to a gurin type device to prevent rotation of the rectangular wire.



Figure 12 - End of treatment with correction of Class II and overjet.

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Case 3 (Figs 13, 14, 15)

Patient with 23 years of age, Class II, increased overjet and overbite, incisors excessively buccally inclined. The treatment plan included the insertion of mini-implants between molars and seconds upper premolars, at a height of approximately 7 mm. Extractions of the upper first premolars for overjet correction was performed.

In upper anterior retraction stage, a 0.017 x 0.025-in stainless steel wire was inserted, in order to allow some loss of inclination of anterior teeth. At the end of 25 months of treatment, the upper incisors had a satisfactory inclination and the canines were in Class I.

Retraction using Centrex System 1 (CS1)

Orthodontic treatment with continuous arches, whether it's with pre-adjusted or standard brackets, follows a similar protocol in the various existing techniques. In cases with extraction, planning can vary according to the presence or absence of crowding. In the case of crowding, when protrusion of anterior teeth is not desired, tooth extraction is first performed and then the initial canine retraction, that, depending on the technique, can be total or just enough to dissolve the crowding, eliminating the tooth-arch discrepancy. From there on, the wires are changed until insertion of a rectangular wire for retraction. In cases without crowding, tooth extractions can be performed only at the time of retraction of anterior teeth. This protocol has, besides the obvious esthetic purpose, the purpose of avoiding loss of alveolar bone mass, which would occur between the time of extraction and the beginning of the retraction stage. As we all know, few steps prior to the retraction of anterior teeth may take a few months, depending, mainly on the correction of potential deep overbites.

The treatment protocol with the Centrex System 1 (CS1) is similar to a standard treatment. It consists of leveling and alignment of teeth with continuous arches until the retraction rectangular wire. At the end of this stage it is essential that in the lower arch, the curve of Spee has been corrected, enabling the retraction of the upper anterior teeth. Before the beginning



Figure 13 - Upper incisors showing excessive inclination.

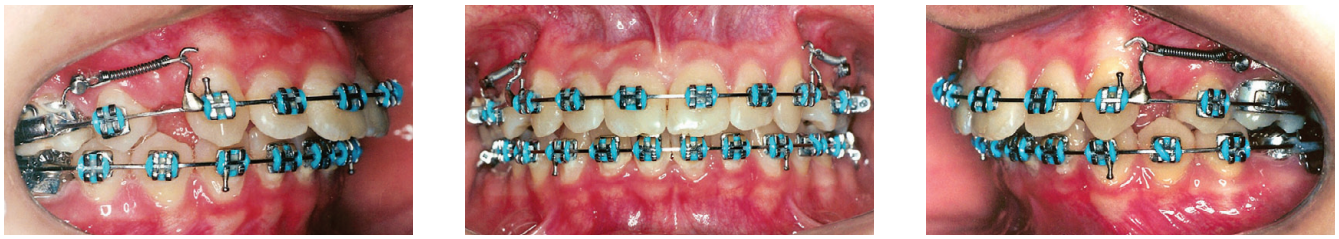


Figure 14 - Stage of upper anterior retraction with welded hooks to rectangular 0.017 X 0.025-in wire.



Figure 15 - End of orthodontic treatment.

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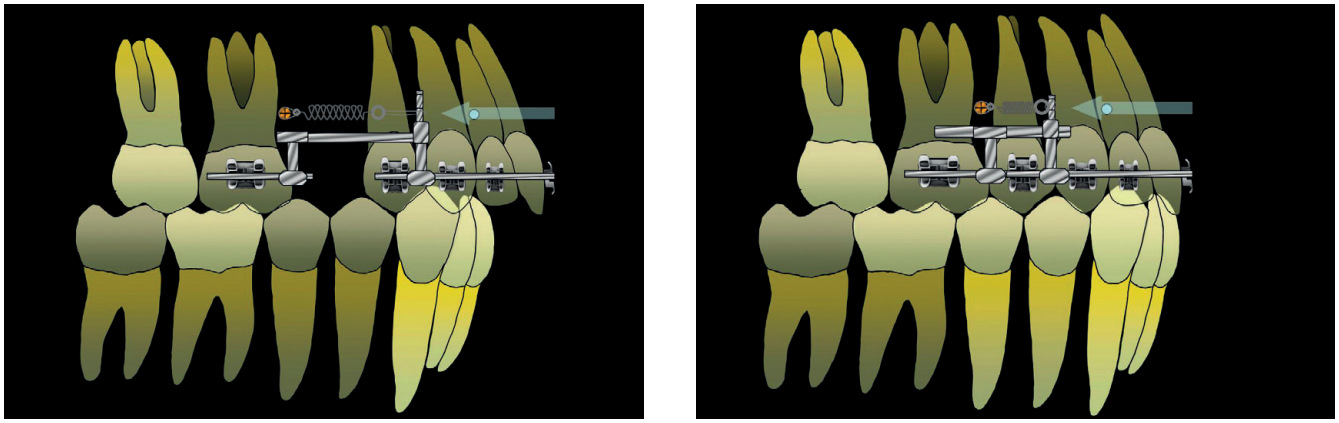


Figure 16 - Retraction of the upper anterior teeth when these are with ideal inclination.

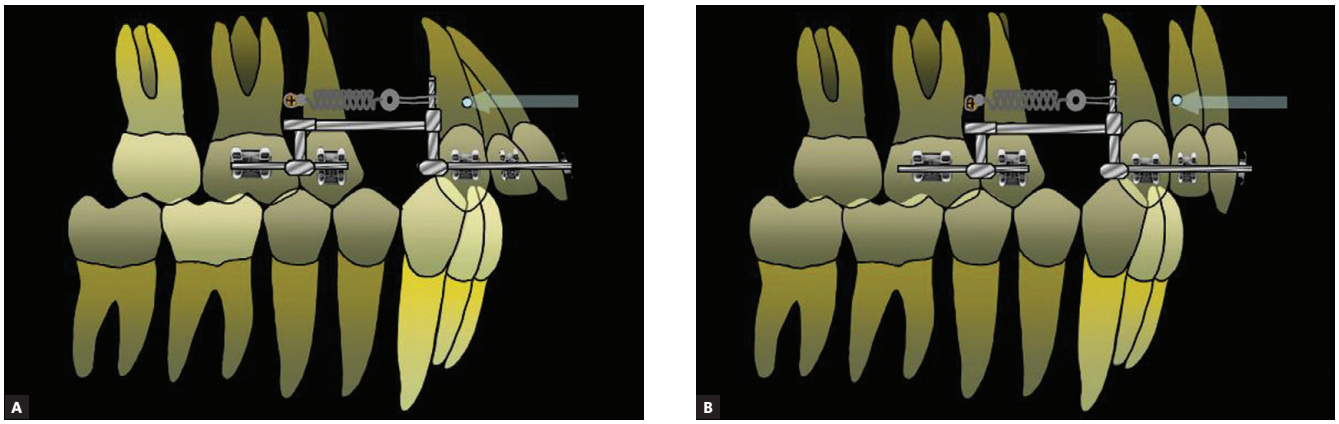


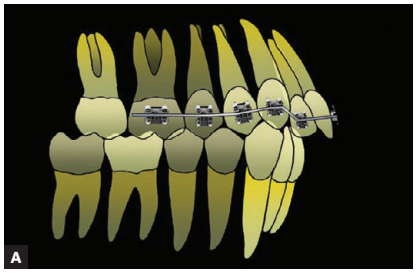
Figure 17 - Anterior teeth with excessive buccal inclination (**A**). Anterior teeth with insufficient inclination before the retraction (**B**).

of the next stage, the inclination of these teeth is evaluated to define the need for adjustments.

Here, three situations are possible: The upper incisors can be with the ideal inclination for the case, they can be with excess of buccal inclination (positive) or with a negative inclination. When the upper anterior teeth present an ideal inclination, the goal is to keep them during the retraction phase. To do this, the wire must fill the entire slot for these teeth, thus avoiding the loss of inclination of units to be retracted. The MI are inserted at a height that approaches the center of resistance of the anterior teeth, whose location can be more apical if there is horizontal bone loss in the anterior region.[1] If the line of force is passing parallel to the occlusal plane and at the center of resistance of teeth that are being moved, the trend is that these teeth will move bodily in a distal direction, without vertical components (Fig 16).

In the case when upper incisors present an excessive buccal inclination at the end of alignment and leveling stage (Fig 17A), treatment occurs in the same way as a treatment with continuous arches. Although inclination correction is possible before the beginning of retraction, this is not the most appropriate approach, since such a correction can be easily achieved during the distal movement of anterior teeth. To do this, the rectangular wire, used to retract, does not fill the whole slot of anterior brackets. For example: a wire measuring 0.018 x 0.025-in in a slot 0.022 x 0.030-in would allow a slow loss of inclination to the point that we consider ideal. From there, if an additional retraction is required, one can replace the wire by a larger caliber, allowing greater control of incisors.

When the upper anterior teeth present inadequate buccal inclination (Fig 17B), in the same way as conventional mechanics the prior correction of such inclination is required before the beginning of the anterior retraction movement. Facing that situation,



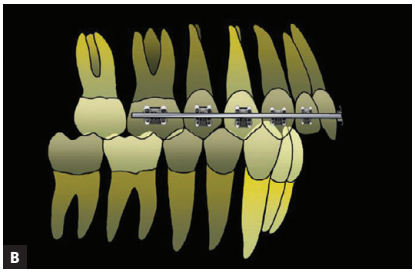
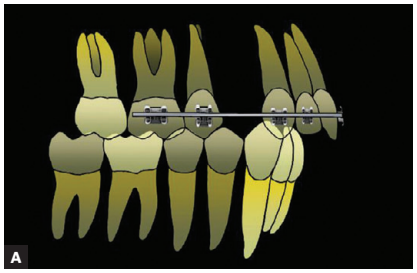


Figure 18 - Summary of Protocol for using CS1: The alignment and leveling of teeth follow by the use of wires of smaller caliber and greater resiliency (**A**), until reaching the rectangular wires, when all the teeth must be correctly aligned and leveled in the arch (**B**).



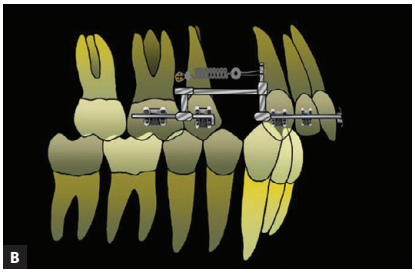


Figure 19 - When the upper teeth are ready to be retracted, extraction of teeth is performed chosen in planning (if they have not been previously extracted) (**A**). The mini-implants are inserted in the positions shown for the case and the CS1 is installed on the upper arch, which is sectioned, individualizing the anterior and posterior segments (**B**).

the best practice is to continue wire changes up to the rectangular wire of higher caliber compatible with the slot, that will allow full torque expression embedded in pre-adjusted brackets. It is like active buccal crown torque was given to anterior teeth. What can even be necessary if the option is to use standard brackets. After execution of torque correction, the UAR can be initiated with the CS1 installation and sectioning of continuous wire, separating the two segments (Figs 18 and 19), which avoids the friction between the wire and brackets during the retraction movement. Below are presented clinical cases treated with the protocol described.

It is an adequate time for a caveat: it is not the intention here to reduce the success of orthodontic mechanics to a simplistic generalization of location of centers of resistance as if they were easily locatable structures. They are not. Several works were conducted attempting to identify its position on different teeth and groups of teeth, without any agreement.[18,22] In addition, some factors impose additional difficulties to their location, that varies depending, especially on the anatomy of the teeth, the form and amount of bone support and amount of teeth involved in the movement.[22]

With didactic purpose, let's consider, as stated by Smith and Burstone,[4,25] for teeth with healthy periodontium an approximate location of the center of resistance between the trifurcation of molars. For the block of six anterior teeth we will consider a height of about 10 mm, apical in relation to brackets, and approximately between the roots of the upper lateral incisor and canine. It should be borne in mind, however, that this is merely an estimate and that the exact location setting gives more by way of trial and error and by momentary adjustments during mechanics

Case 4 (Figs 20, 21, 22)

Female patient looked for orthodontic treatment presenting a bilateral Class II relation, upper anterior and lower posterior crowding in the right side; the upper midline was deviated to the right. In radiographic evaluation, a predominantly horizontal bone loss was detected in the upper anterior region. The treatment plan consisted of the extraction of two first upper premolars, in addition to the second lower pre-molar on the right side. The aim was to lose anchorage in the right side in both the upper and the lower arches, and retract the upper segment for midline correction. When inserting the rectangular wire of 0.019 x 0.025-in we initiated the retraction of the left side using the CS 1, which made it possible to establish a higher line of force, which was in line with our planning to maintain the inclination of the upper anterior teeth during retraction.

At the end of treatment, the patient had corrected canine relationship and upper midline, keeping the inclination of the upper incisors.



Figure 20 - Bilateral class II malocclusion with crowding in upper anterior and lower posterior right regions.



Figure 21 - UAR is a good moment for upper midline correction. In this case, the emphasis is on the left side retraction with CS1 seeking the midline correction.



Figure 22 - End of retraction with midline and bilateral canine relationship corrected.

Case 5 (Figs 23 to 26)

Female patient presented, at the beginning of treatment, a ½ Class II canine relation, increased overbite and overjet, that were aggravating due to pathological occlusion. Bone loss in the anterior region of the upper and lower reached the middle apical third. The treatment was performed with the extraction of upper and lower first premolars and insertion of mini-implants buccally positioned between first and second upper molars, at a height of approximately 10 mm above orthodontic wires. As bone loss produced an apical migration of the center of resistance of anterior upper teeth, the line of force, established during the UAR phase, was set up approximately 10 mm from the brackets center allowing a small clockwise tendency for the inclination of the anterior block. Once the inclination of the upper anterior teeth was considered acceptable, a rectangular wire 0.021 x 0.025-in was inserted to increase inclination control of teeth during the remaining retraction.

At the end of the treatment, overjet, overbite and the exaggerated inclination of incisors were corrected with appropriate control of bone loss.

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Figure 23 - Beginning of treatment. Opening of anterior teeth exacerbated by occurrence of a pathological occlusion.

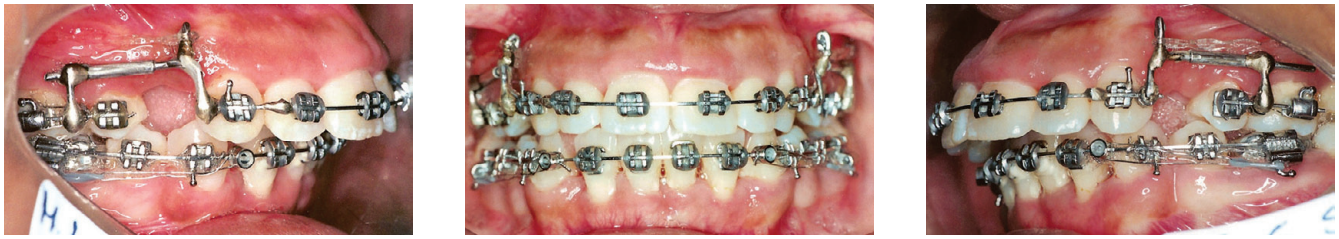


Figure 24 - Active stage of UAR using CS 1.



Figure 25 - End of anterior retraction with overjet correction.

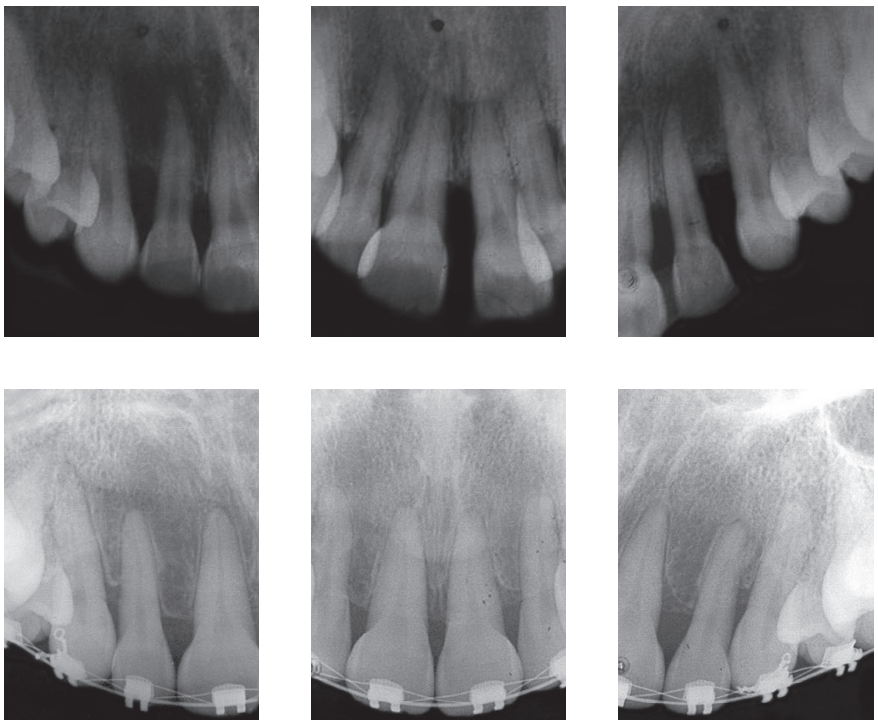


Figure 26 - Radiographic detail of bone loss in the region of upper incisors before treatment and after the retraction stage of upper anterior teeth. The intrusive movement of these teeth led to, on one hand, to apical rounding and, on the other hand, positively, to an improvement in bone insertion levels, providing a beneficial change in the ratio between the resistance arm (root portion inserted into bone) and the lever arm (tooth portion outside of the bone).

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Case 6 (Figs 27, 28, 29)

The next case discusses the use of CS 1 for correction of upper and lower midlines in a patient previously treated with asymmetrical extractions. The tooth extraction of an upper premolar on the left and another on the right side on the lower arch, produced a complete Class II relation in the right side and a complete Class III in the left side. The two midlines were deviated in opposite directions (Fig 27). Since the goal was to correct midlines without a large inclination of anterior teeth, the mini-implants were inserted at 10 mm in height, in relation to brackets, and retraction rectangular wires had a caliber of 0.021 x 0.025-in. At the end of the treatment the canines and the midlines were corrected. There was, as planned, small change in inclination of the upper and lower teeth.



Figure 27 - Complete Class II malocclusion in the right side complete Class III in the left side, resulting from previous orthodontic treatment with asymmetrical extractions.



Figure 28 - Asymmetric retraction. In this case, It is important to immobilize the wire on the opposite side to avoid its rotation.



Figure 29 - End of treatment with correction of midlines and canine relation.

Case 7 (Figs 30, 31, 32)

This case presents the treatment of a bilateral complete Class II. The planning consisted of extraction of teeth 26 and 15. It is important to point out that the choice of tooth 26 was due to the absence of teeth 25, previously extracted, which imposed an additional difficulty to the case, because of the need for asymmetrical extractions. After leveling and alignment up to the 0.021 x 0.025-in rectangular wire in the upper arch, two mini-implants were inserted at a height of 12 mm in relation to the wire and two CS 1 appliances were used, which have enabled the institution of action line of strength high enough to allow an adequate control of the inclination of upper anterior teeth, which already had a satisfactory buccal lingual position at the onset of treatment.

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Figure 30 - Class II malocclusion (complete), with upper incisors showing good inclination.



Figure 31 - Bilateral UAR with CS1 appliances.



Figure 32 - Bilateral correction of Class II canine relation.

Case 8 (Figs 33, 34, 35)

Patient 28 years old, presented primary lower crowding and upper incisors protruded in their base, yet with almost ideal inclination. The treatment plan consisted of extracting the first four premolars, with the aim of resolving lower tooth arch discrepancy and incisor protrusion. The MI were inserted in the maxilla bilaterally, at a height of approximately 10 mm from the wire. In UAR, a 0.021 x 0.025-in wire was inserted to maintain the ideal incisor inclination.

DISCUSSION

The retraction of anterior teeth is apparently just a simple procedure in orthodontic mechanics, however the possible problems during this phase, many of them listed in this work, indicate the contrary. It is a defiant step for the clinician, when one needs to control with enough rigour the undesirable side effects that eventually appear in your course.

One of the most common disadvantages during anterior retraction, with sliding mechanics, is the blocking of movement generated by the friction between the wire and the bracket.[5,30] For Kusy,[15] the sliding of a wire inside brackets tends to decrease the mechanical efficiency, demanding an increase in the strength used to compensate for this loss. The magnitude of the friction between bracket and wire varies according to the chemical composition of each one[16] and the wire caliber.[3,13] Rectangular wire sectioning within the retraction space, when using CS1, aims to reduce the friction wire/bracket during the distal movement of anterior teeth, which tends to avoid unnecessary loss of mechanical efficiency at that stage, thus allowing the use of smaller magnitude forces, within the physiological adaptation pattern of the periodontium.

Torque control during retraction of six anterior teeth is another topic that can be quite challenging. The incorporation of root lingual torque is often



Figure 33 - Class I Malocclusion with lower anterior crowding and protruded upper incisors.



Figure 34 - The upper anterior teeth had good inclination during the retraction phase.



Figure 35 - End of retraction, with maintenance of correct inclinations of upper incisors.

required to avoid excessive retroclination extrusion of the crowns of anterior teeth.[19] Additionally, a compensatory bend can be incorporated to the wire to compensate the extrusive effect of anterior teeth,[20] however, this adds friction to the process, which may result in a delay during movement of such teeth.

The occlusal gingival position of MI associated to the height of retraction hooks height in the anterior segment determine the line of force that is generated during the movement of anterior teeth. The possibility of establishing different configurations of line of action towards the center of resistance of these teeth admits various movements without the need of making compensatory torques on incisors.[20] The CS1 allows use of retraction forces in many heights and can generate planned movements of anterior teeth only with the management of the point of origin and force application. Another possibility for manipulation of desired movement takes place by the choice of the caliber of the retraction wire.

It is speculated that the contact of the root apex with the buccal or lingual cortical can be one of the main factors of root resorption during orthodontic treatment.[11] Such contacts are often generated during uncontrolled inclination movements of incisor teeth in retractions or buccal movement of such teeth. Alveoli with reduced thickness, as is often found in patients with increased facial height, can increase the risk of root resorption.[10]

It is not entirely clear if the tooth movement in situations of retraction of anterior teeth raises a complete alveolar remodeling around the moved teeth. Edwards[9] believes that such a remodeling occurs in the segment between the alveolar margin and the middle third of the root, not occurring to the apical third level. For him, if the applied forces are within the limits of tissue tolerance, the bone

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remodeling moves the alveolus with the tooth. Some authors share the same hypothesis,[8,20] while others argue that any tooth movement that forces incisors against the cortical bone can cause sequelae, such as root and cortical bone resorption, in addition to the tooth exposure.[23,29] The proposal of CS1 is that, through the rigorous control of orthodontic movement, it can decrease the risk of pressing the apical region against the cortical bone, thereby reducing the chances of root resorption during the retraction stage.

It is essential to assess the magnitude of the facial changes induced by tooth retraction. Although this might be welcome in some individuals presenting, for example, lip protrusion as the first clinical case presented in this text.

CONCLUSIONS

This work presented a treatment possibility with a device that approximates the line of action of forces to the center of resistance of the teeth that are being moved, thereby reducing some of the harmful side effects during anterior retraction.

The Orthodontist having at his reach a series of different orthodontic techniques and therapeutic resources, can choose the best option for closing spaces originated from extractions in the upper arch. The proposal of CS1 is the use of biomechanical features based on fundamental knowledge of Orthodontics. The possibility of placing MI in various positions gives us the therapeutic versatility needed to choose the type of desired movement through manipulation of the line of action of forces.

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Comparative study of frictional forces generated by NiTi archwire deformation in different orthodontic brackets: *In vitro* evaluation

Gilberto Vilanova Queiroz[1], Rafael Yagüe Ballester[2], João Batista De Paiva[3], José Rino Neto[3], Giselle Mara Galon[4]

Introduction: The purpose of this study was to compare the frictional forces between 0.014-in NiTi wires (Aditek) with 4 mm horizontal deflection and brackets with different archwire ligation systems.

Methods: Four types of self-ligating brackets (Damon MX, Easy Clip, Smart Clip and In-Ovation), a triple bracket (Synergy) and a twin bracket with 8-shaped ligature (Tecnident) were tested. Twin brackets with conventional elastomeric ligatures (Morelli) were used as control group. Tests were repeated 10 times for each bracket/archwire combination. Frictional forces were measured in an Instron universal tensile machine at 3 mm/minute speed and a total displacement of 6 mm. Statistical analysis comprised ANOVA and Dunnett's multiple comparison post hoc test.

Results: Deflection-induced frictional (DIF) forces increased in the following order: Synergy, Damon, 8-shaped Ligature, Easy Clip, In-Ovation, Smart-Clip and conventional ligatures. The differences among groups were significant, with the exception of the 8-shaped ligature groups which was equal to the Damon and Easy Clip groups.

Conclusions: Compared to conventional ligatures, all ligation systems tested reduced frictional forces. However, such reduction varied according to the ligation system employed.

Keywords: Orthodontic brackets. Friction. Corrective Orthodontics.

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How to cite this article: Queiroz GV, Ballester RY, De Paiva JB, Rino Neto J, Galon GM. Comparative study of frictional forces generated by NiTi archwire deformation in different orthodontic brackets: In vitro evaluation. Dental Press J Orthod. 2012 July-Aug;17(4):45-50.

Submitted: March 25, 2009 - **Revised and accepted:** October 20, 2010

» The authors report no commercial, proprietary or financial interest in the products or companies described in this article.

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INTRODUCTION

Straight wire technique is the most widely used in contemporary orthodontic treatments and its effectiveness depends on two basic factors: Archwire/bracket sliding and the amount of orthodontic forces effectively delivered to the periodontium.[1] The frictional forces present in the archwire/bracket interface play an important role in this context because it opposes archwire/bracket sliding, thereby decreasing the amount of force delivered to the periodontium for tooth movement.[6,7,12]

Determining the approximate magnitude of friction in different clinical situations can assist in identifying the actual force employed in moving teeth, thus enabling professionals to apply light forces to the periodontium while stimulating maximal biological forces in the tooth being moved and minimal bone remodeling in the anchorage tooth.[2]

Two basic types of friction that restrict orthodontic sliding mechanics can be found at the archwire/bracket interface: The ligation friction produced by elastomeric or steel ligatures when the archwire is compressed against the bottom of the slot, and the deflection-induced friction (DIF) generated by compressing the deflected archwire against the bracket slot.

By eliminating ligation friction in the stage of tooth alignment one can optimize the action of superelastic archwires and produce sliding mechanics with light, continuous forces with the purpose of moving teeth. Self-ligating brackets, Slide unconventional elastomeric ligatures (Leone) and 8-shaped ligatures (Tecnident) as well as the special Synergy (Rocky Mountain) and Delta Force (Ortho Organizers) brackets are effective and equivalent options for the control of friction in the phase of dental leveling and alignment.[1,3,4,5]

Archwire deflection-induced friction usually takes place in the initial phase of orthodontic treatment when the orthodontic slots are in different planes. Archwire deflection creates the forces responsible for correcting malpositioned teeth and simultaneously exerts pressure on anchorage teeth, generating deflection-induced friction, which undermines tooth movement effectiveness. The magnitude of archwire deflection-induced friction, also called binding, depends on the intensity of force with which the archwire presses against the walls of the anchorage brackets and is influenced by interbracket distance, diameter and type of orthodontic wire alloy.

In malocclusions displaying deviations in the horizontal plane (lingual or buccal), the archwires are deflected and compress the bracket slot closing system. In light of the differences in bracket design and friction coefficient of the materials employed in the manufacture of slot closing systems, it is important to assess whether the magnitude of the friction generated through archwire deflection is similar between brackets with different slot closing systems.

The purpose of this study was to compare frictional forces generated by 0.014-in NiTi wires subjected to 4 mm horizontal deflection in brackets featuring different slot closing systems.

MATERIAL AND METHODS

A test device with 5 brackets, representing the central and lateral incisors, canine, first and second premolars of the upper left quadrant, was used to compare the frictional forces produced by different archwire ligation systems: Four types of self-ligating brackets were tested, Damon MX (Ormco), Easy Clip (Aditek), In-Ovation (GAC) and Smart Clip (3M/Unitek), as well as the Synergy triple bracket (Rocky Mountain Orthodontics) and twin brackets (Morelli) tied to the archwires with 8-shaped ligatures (Tecnident). Twin brackets (Morelli) tied conventionally with elastomeric ligatures (Morelli) were used as control group. Five bracket sets with 0.022 x 0.028-in slots were employed for each ligation system tested.

The test device had 5 sliding cylinders which acted as support for bonding the brackets, and two 0.022 x 0.028-in guiding slots located at the ends of the area designed for the brackets (Fig 1). Direct bonding of the brackets was performed individually and followed this sequence: Seating of straight 0.021 x 0.025-in steel archwire in the guiding slots; insertion of a standard 0.022-in thick ruler in the guiding slots while compressing the 0.021 x 0.025-in archwire; application of primer to the bracket base and initial placement of support cylinder; sliding of support cylinder until the 0.021 x 0.025-in archwire was seated in the bottom of the slot throughout the wire's mesiodistal extent, thereby

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determining the final bonding position (Fig 2); Direct bonding with cyanoacrylate (Superbonder, Henckel/Brazil) proved strong enough to stabilize the brackets during the mechanical tests, even in the specimens where there was no full contact between bonding surface and bracket (Fig 2). The distance between the bracket centers' was 7.5 mm.

A straight superelastic NiTi wire (Aditek) with 0.014" cross-section and 12 cm length was employed in the tests in an active configuration. The wire was stabilized inside the slot through the various self-ligating brackets, through 8-shaped ligatures on the Morelli brackets, throughconventional elastomeric ligatures on Morelli brackets and through the center tie-wings of Synergy brackets.

To simulate a scenario of linguoversion, the cylinder where the upper canine bracket was positioned was loosened and shifted horizontally by 4 mm, producing elastic deflection in the 0.014-in NiTi wire as well as deflection-induced friction (Fig 3).

The wire was pulled until it slid inside the bracket slot and the deflection-induced friction forces were recorded. A model 5565 Instron universal mechanical testing machine was used with a load cell of 500 Newtons and a speed of 3 mm/minute. Parallelism between the testing device and the latch on the Instron machine was achieved by inserting the tip of a standard 0.022-in thick ruler in the guiding slots while the opposite tip contacted the right wall of the latch, which remained stationary. The closing and opening of the latch was carried out by laterally displacing the left movable wall (Fig 4).The machine was calibrated prior to the experiment. Starting from the initial movement of the archwire the forces were recorded at

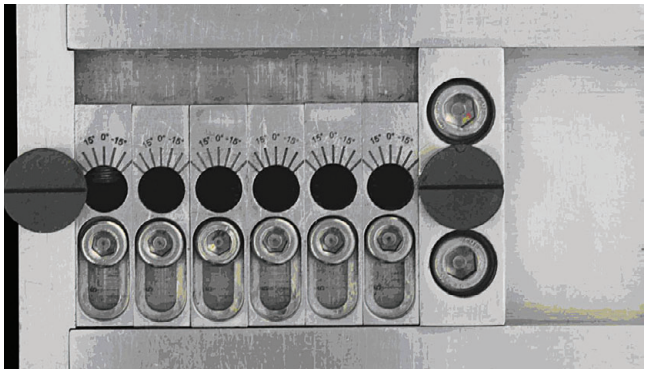


Figure 1 - Device with guiding slots at both ends.



Figure 2 - Brackets positioned in a passive configuration.



Figure 3 - Brackets positioned in an active configuration.

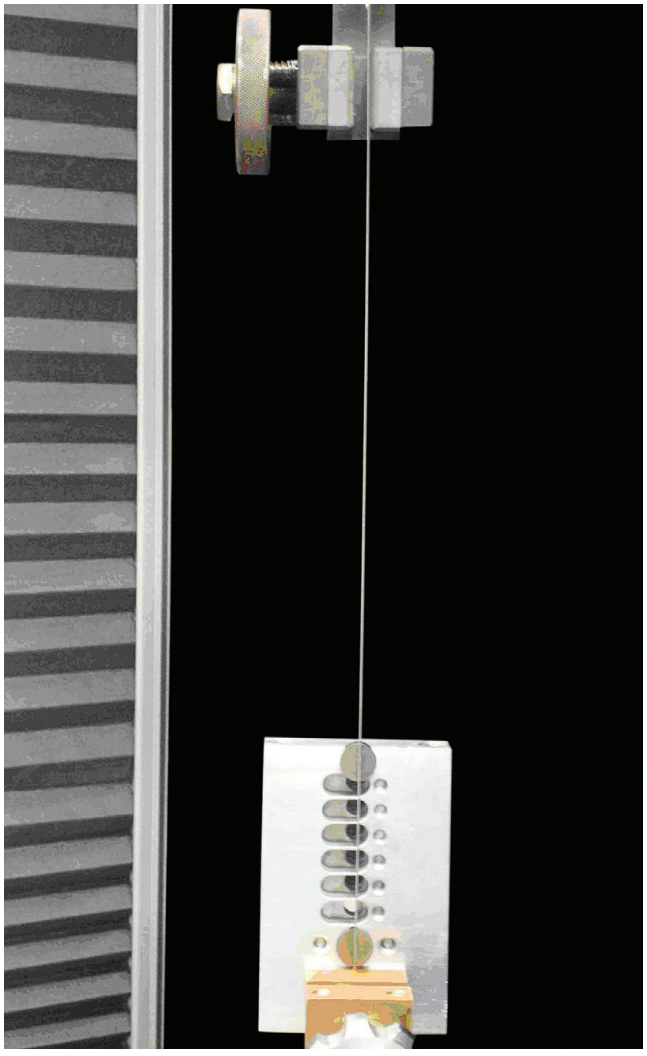


Figure 4 - Device positioned in the Instron machine.

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every 0.1 mm up to a total wire displacement of 6 mm.

Each test was repeated 10 times. The brackets were replaced every other test and the wires and ligatures at every test to prevent changes in the friction magnitude resulting from wear of the contacting surfaces. The elastomeric ligatures were inserted immediately before each test. The tests were performed in a dry environment at a temperature between 24 and 26° C.

STATISTICAL ANALYSIS

Means and standard deviations were calculated and normality tests applied for each orthodontic archwire/bracket combination. The differences between the 7 archwire ligation methods were analyzed by ANOVA. In order to identify which groups were different, Dunnett's multiple comparison test for groups with unequal variances was employed.

A 5% significance level was set for all tests ($p<0.05$).

RESULTS

Table 1 depicts the descriptive analysis of friction forces with the 0.014" NiTi wire in an active configuration and the direct comparisons between ligation methods using Dunnett's test. The lowest mean magnitude of friction was 222 gf (gram/force), achieved by Synergy brackets. Archwire ligation with 8-shaped ligatures also produced a low magnitude of friction, of about 279 gf. Damon, Easy Clip, In-Ovation and Smart Clip self-ligating brackets exhibited wide variations in friction forces, yielding the following respective values: 270 gf, 317 gf, 405 gf and 543 gf. Conventional Morelli brackets with conventional ligatures reached higher values, which averaged 770 gf.

The last column of Table 1 indicates the ligation methods whose results were similar according to Dunnett's multiple comparison test ($p<0.05$). In general, there were significant differences between the groups, with the exception of the 8-shaped ligatures used with Damon and Easy Clip brackets.

Figure 5 shows the percentage differences in friction magnitude using as a horizontal reference line the value of 270 gf obtained by Damon brackets. This reference line was determined because this bracket is very widely used in orthodontic practice. Synergy brackets exhibited a 17% lower friction force and 8-shaped ligatures only 3% higher than Damon. Easy Clip, In-Ovation, Smart Clip and conventional Morelli brackets showed increments in friction forces equivalent to 17%, 50%, 100% and 185%, respectively.

DISCUSSION

In sliding mechanics, the force applied to a tooth is not fully delivered to the periodontium because the friction force at the archwire/bracket interface opposes the sliding archwire and thereby dissipates part of the force designed to move teeth.[6,7,12] Therefore, orthodontic forces must first overcome friction while the remaining force promotes bone remodeling, causing teeth to move.[1,5,7]

Damon MX, Easy Clip, In-Ovation, Smart Clip self-ligating brackets, special Synergy brackets, and conventional Morelli brackets with 8-shaped ligatures are effective in eliminating ligation friction when the archwire is flat and undeflected. The purpose of this study was to investigate whether or not the different slot closing methods described above produce similar friction magnitudes when the archwire is subjected to deflection. Twin brackets

Table 1 - Descriptive statistics in grams-force. Similar methods based on friction magnitudes with no differences according to Dunnett's multiple comparison test ($p<0.05$).

Ligation Method	Mean	SD	Similar methods
Synergy	222	15	-
Damon	270	14	8-shaped ligatures
8-shaped ligatures	279	32	Damon, Easy Clip
Easy Clip	317	37	8-shaped ligatures
In-Ovation	406	30	-
Smart Clip	543	35	-
Conven. Lig.	771	73	-

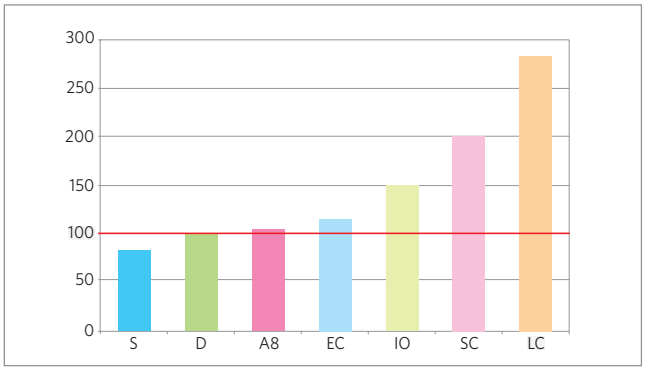


Figure 5 - Percentage changes in friction force between the brackets evaluated using Damon brackets as reference (Fati = 270gf).

with conventional elastomeric ligatures (Morelli) were used as control group.

Nickel titanium wires were used because the authors were interested in examining friction magnitude in the initial phase of orthodontic treatment when archwires with a low modulus of elasticity are indicated. Horizontal deflections of 0.014-in NiTi wires were standardized at 4 mm with the purpose of enabling them to reach full superelastic regime, since NiTi archwire deflections around 2 mm may be insufficient to bring out the superelastic properties of archwires.[11,9]

In order to assess the actual orthodontic forces and friction applied to teeth, in vitro studies using an active configuration must reproduce the actual interbracket distances.[11] A 15 mm distance was adopted between bracket centers that act as support for deflection in the canine region because this corresponds to the average distance between lateral incisor and maxillary first premolars.

In this study, self-ligating brackets, Synergy brackets and 8-shaped ligatures produced frictional forces significantly lower than conventional brackets tied to the archwires with conventional elastomeric ligatures, corroborating the findings of Kim et al.[7] This was expected as there was no sum of ligation friction plus archwire deflection-induced friction.

Although the same archwire diameter, alloy and deflection were used in all slot closing systems tested, the magnitude of the deflection-induced friction forces produced by the archwires were not uniform. Frictional forces gradually increased in the following order: Synergy, Damon, 8-shaped Ligature, Easy Clip, In-Ovation and Smart-Clip. With the exception of the 8-shaped ligatures in relation to the Damon and Easy Clip brackets, all other groups showed significant differences. Such differences are probably related to the influence exerted by bracket design on wire stiffness.

Archwire deflection can be mechanically described as a beam supported by brackets at both ends. The activation force (Facti) deflect the wire at the midline, generating symmetric reactions at the left and right points of support. Reaction forces can be represented by a normal force (FN) perpendicular to the archwire at the point of contact with the slot, the friction force (Ffric) that opposes the direction of the sliding archwire and opposite moments (M) inside each support bracket10 (Fig 6).

Normal force (FN) intensity at the archwire/bracket interface depends on archwire stiffness. Since the (a) archwire diameter, (b) type of alloy, (c) 4 mm deflection and (d) average distance of 15 mm between the centers of the cylinders used as support for bonding the brackets were all standardized, the variables that influence archwire stiffness are the bracket width and the material used to manufacture the slot closing system.

Bracket width affects archwire stiffness because it modifies the effective interbracket distance. According to Whitley and Kusy,[13] the total interbracket distance (IBD) should be measured between the centers of the support brackets (Fig 7). The effective interbracket distance (IBDe) equals the IBD minus half the width of the right support bracket (L1), the width of the interposed bracket (L2) and half the width of the left support bracket (L3). Therefore, the greater the width of the bracket, the shorter the effective length of the interbracket archwire, causing increased stiffness, increased archwire/slot normal compression force (NF) and increased archwire

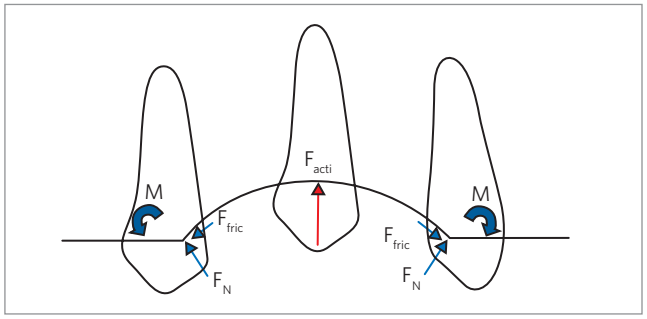


Figure 6 - Free body diagram during archwire activation. Adapted from Nikolay[10].

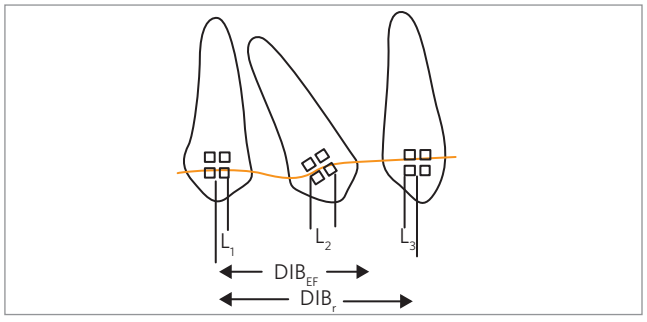


Figure 7 - Parameters for determining the effective interbracket distance. Adapted from Whitley and Kusy[13].

deflection-induced friction force. Given that the stiffness of a round cross-section beam is inversely proportional to the third power of its length,[10] the influence exerted by bracket width on archwire stiffness becomes clear.

Table 2 shows the widths of the brackets assessed in this study. The widths of the slot closing system or elastomeric ligatures placed on the tie-wings of canines are clearly marked because in these brackets first-order deflections occurred at the archwire/closing system or archwire/ligature interface. Therefore, the closing systems and ligatures reflect the effective bracket widths.

The material employed in the bracket slot closing system can influence the force of the archwire deflection-induced friction according to its flexibility and friction coefficient. When the slot closing system is resilient it may be somewhat deflected, which results in decreased horizontal deflection of the archwire inside the slot, thus reducing the normal force intensity at the wire/bracket interface. This may be one of the reasons underlying the good performance of systems that use elastomeric ligatures for bracket ligation. In addition, the horizontal deflection of a 0.014" NiTi wire causes it to contact the slot closing system. Moreover, the portion of normal force (FN) converted into deflection-induced friction forces varies according to the friction coefficient of the different materials used in the manufacture of the slot closing systems. Thus, friction coefficients also contribute to the differences found in the magnitude of archwire deflection-induced friction.

Table 2 - Bracket widths.

	Central incisor	Lateral incisor	Canine	Premolar
Damon	2.7	2.7	2.1	2.7
Easy Clip	3.2	3.2	2	3.2
In-Ovation	2.9	2.6	2.9	2.9
Smart Clip	3.7	3.2	3.5	3.4
Synergy	2.6	2.5	2.6	2.6
Morelli	3.6	2.4	3.4	3.4

It should also be emphasized that frictional forces interfere with orthodontic movement as they reduce the forces delivered to the periodontium. Thus, the results found in this study suggest that archwires with similar activations, seated in brackets with different slot closing systems can deliver significantly different forces to the teeth.

CONCLUSIONS

1) Compared to conventional ligatures, all closing systems tested were effective in reducing friction forces.
2) The frictional force produced by deflection of NiTi archwires varies significantly according to the closing system selected.

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Assessment of surface friction of self-ligating brackets under conditions of angulated traction

Roberta Buzzoni[1], Carlos N. Elias[2], Daniel J. Fernandes[3], José Augusto M. Miguel[4]

Objective: The aim of this study was to assess resistance to sliding of stainless steel passive self-ligating brackets with 0° and 2.5° angulations and to compare them to active self-ligating brackets at zero angulation. The hypothesis to be tested was that passive self-ligating brackets produce lower frictional forces than active self-ligating brackets.

Methods: Twenty five 0.022 x 0.028-in slot maxillary canine brackets were divided into 5 groups of 5 brackets: Damon SL II (Ormco, CA, USA) self-ligating bracket and Gemini (3M/Unitek, CA, USA) conventional bracket with angulation of 0 and 2.5° and a group of Speed 2 (American Orthodontics, WI, USA) active clip self-ligating system with zero angulation. Twenty five segments of stainless steel 0.020-in archwire (TP Orthodontics, IN, USA) were tested and each bracket/wire interface was evaluated at 4 successive points during sliding. Overall, 100 frictional values were analyzed by parametric analysis of variance and Bonferroni tests.

Results and Conclusion: Frictional tests were performed with an Emic DL 10000 testing machine (Emic, Brazil) with a load cell of one kilogram. Passive self-ligating brackets produced lower frictional forces than active self-ligating brackets ($p < 0.01$). Under angulation, brackets with a slide mechanism produced higher friction than the same brackets under zero angulation ($p < 0.01$). Nevertheless, the slide system under angulation produced smaller friction values than conventional brackets tied with elastomeric ligatures in 0° tests.

Keywords: Orthodontic brackets. Friction. Stainless steel. Ligation.

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How to cite this article: Buzzoni R, Elias CN, Fernandes DJ, Miguel JAM. Assessment of surface friction of self-ligating brackets under conditions of angulated traction. Dental Press J Orthod. 2012 July-Aug;17(4):51-6.

Submitted: April 9, 2009 - **Revised and accepted**: June 8, 2009

» The authors report no commercial, proprietary or financial interest in the products or companies described in this article.

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INTRODUCTION

Maintaining low levels of friction constitutes a concurrent objective when producing orthodontic movement. Frictional forces are dependent on variables such as alloy type, size, shape of the orthodontic brackets[6,16,20] and shape of archwire[2,6,16,20] in addition to characteristics inherent in the interaction between appliances, such as ligation[2,21] and the angulation established between these appliances.[3,7-9]

Self-ligating (SL) brackets are designed to engage the orthodontic archwire in the bracket slot in a unique manner[10,19,21] (Fig 1). Such engagement can be classified as active or passive.[16,58] SL brackets are considered active[2] when they feature a resilient cover capable of exerting constant pressure on the orthodontic archwires.[6,10,21] Contact between archwire and the resilient cover is established only when the archwire has a cross section greater than 0.017-in. Smaller archwires remain fully retained inside the bracket slot without receiving any pressure. In these situations, the self-ligation method can be classified as passive.[10,19] Berger et al described the action produced by the system on tooth alignment and leveling in terms of greater control of rotations and torques.[2] A passive system can also be comprised with a cover mechanism which is capable of holding the archwire passively, regardless of wire cross section. In this model, the bracket slot resembles an orthodontic tube when the cover mechanism is closed.[10,21] Some authors[17,20] believe that this passive model is more efficient in controlling friction than the active mechanism, be the appliance passive or active. The hypothesis to be tested is whether or not self-ligating appliances with a slide mechanism are more effective in controlling frictional forces than appliances with resilient cover mechanisms.

The aim of this study was to assess the frictional forces produced by stainless steel SL brackets with a passive mechanism under zero and 2.5° of angulation and to compare the behavior of this group, without angulation, to active self-ligating brackets.

MATERIAL AND METHODS

This study used 25 canine brackets divided into five distinct groups (Tab 1). The groups comprised Damon SL II, a passive self-ligating system(Ormco, CA, USA) under 0° and 2.5° angulation, Gemini conventional brackets (3M/Unitek, CA, USA) tied conventionally with gray elastomeric ligatures (TP Orthodontics, IN, USA) under the same angulations,

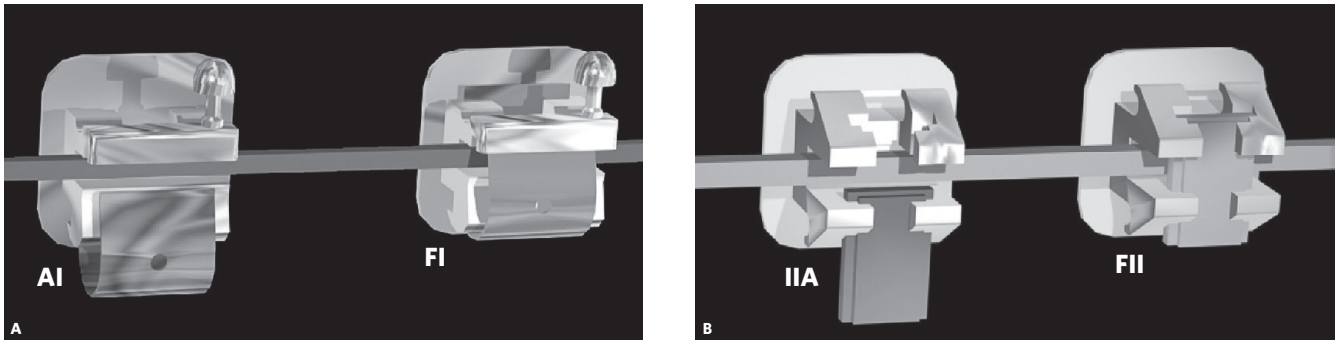


Figure 1 - **A**) Front view of self-ligating brackets fitted with a self-ligation system consisting of a resilient front cover in open (AI) and closed (FI) position, similar to Time 2 brackets. **B**) Front view (II) of self-ligating brackets fitted with an anterior slide mechanism in an open (IIA) and closed (FII) position, similar to what is found in Damon SL II brackets.

Table 1 - Description of groups, ligation system, quantities, pre-angulations and pre-torques in the prescriptions, and angulations used in the bracket traction tests.

Groups	Brackets	Ligation system	Number of brackets	Pre-angulations	Pre-torques	Test angulations
1	Damon SL II	Passive	5	+6°	0°	0°
2	Time 2	Active	5	+9°	-2°	0°
3	Damon SL II	Passive	5	+6°	0°	2,5°
4	Gemini	Elastomeric ligature	5	+8°	0°	0°
5	Gemini	Elastomeric ligature	5	+8°	0°	2,5°

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and a group consisting of Time 2 active self-ligation system(American Orthodontics, WI, USA) under zero angulation (Fig 2). Traction tests used twenty-five 8 cm segments of round 0.020-in stainless steel orthodontic wire (TP Orthodontics, IN, USA). Each bracket/wire set generated four specimens. Analysis of the friction produced by pulling the steel wires inside the bracket slots was assessed based on four consecutive readings. There were twenty specimens in each group, totaling 120 different readings.

The friction of the bracket/wire was measured in an Emic DL 10000 testing machine (Emic, Brazil) with a load cell of two kilograms (kg). In order to offset the different angulations built into the preadjusted brackets, metal cylinders were specially developed with compensatory angulations to ensure that all archwires were positioned parallel to the bracket slots (Fig 2). These stainless steel cylinders were connected to the testing machine while the appliances were bonded with the aid of Super Bonder instant adhesive (Loccite, Brazil). The bracket bases were filled with Transbond XT light-cure adhesive (3M/Unitek, CA, USA) in order to standardize the bonding area (Fig 3). In the groups where angulations were included, the cylinder was rotated 2.5° in the base part connected to the testing machine (Fig 4).

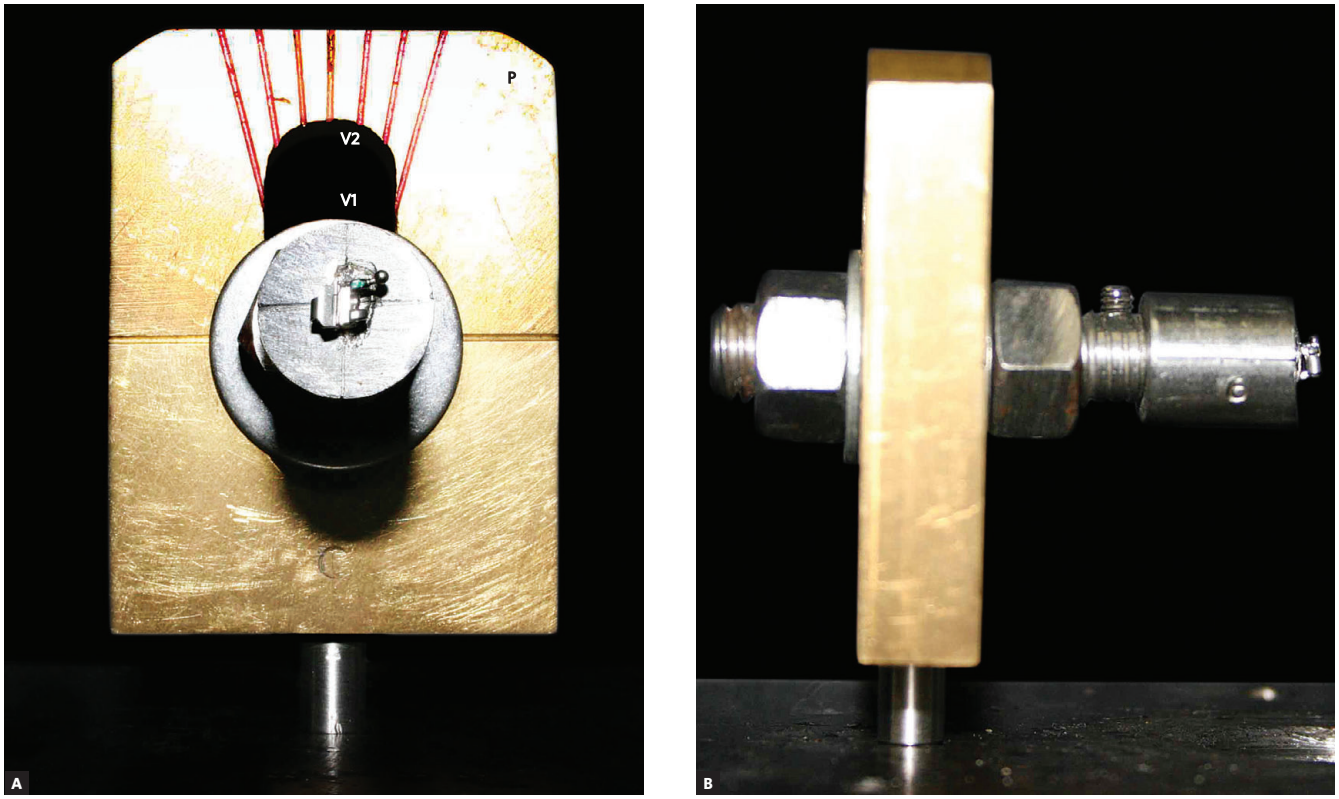


Figure 2 - **A**) Front view of a Time 2 bracket bonded to a metal cylinder with -9° offset angulation to ensure that the wires are pulled without tip or torque. Total absence of angulation (tip) can be confirmed by aligning the existing vertical markings VI and VII with the metal cylinder and with a copper colored part (P) seen in the background. (II) Side view of the same appliance described above. Note the number printed on the cylinder denoting a -9° offset angulation (tip). **B**) Side view of the same appliance described above. Note the number printed on the cylinder denoting a -9° offset angulation (tip).

Table 2 - Self-ligating brackets, test angulations, surface friction means in gram-force (gF), standard deviations and number of specimens subjected to round 0.020-in stainless steel wire traction.

Self-ligating brackets	Test angulations	Means (gF)	Standard deviations	Specimens (n)
Damon SL II	0°	1.171[a]	0.6461	20
Time 2	0°	3.219[b]	0.5239	20
Damon SL II	2.5°	18.53[c]	3.507	20

Conventional Gemini brackets under 0° angulation: Mean (gF) = 114.4.
Conventional Gemini brackets under 2.5° angulation: Mean (gF) = 183.5.
ANOVA: Different letters imply different means by the Bonferroni multiple comparisons test ($p < 0.01$).

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The archwires used in the Gemini groups were tied with elastomeric ligatures, which were changed at every test (Fig 4).

The orthodontic wires were pulled at a speed of 5 mm/min covering a distance of 3.5 mm (Fig 2). Maximum force (gF) values were recorded using Tesc software, version 3.04 (Emic, Brazil).

Mean values were compared by analysis of variance (one way ANOVA) and corrected with the Bonferroni coefficient. All analyzes were performed with Graphpad Prism software version 4.0 (Graphpad Software, CA, USA).

RESULTS

Distribution of force (gF) values are depicted in a box-plot chart. (Fig 5). Distribution was not normal according to the Shapiro-Wilk test ($p < 0.05$).

The data is summarized (Table 2) by means and standard deviations. Friction was evaluated and compared in grams-force (gF) under traction with a round 0.020-in stainless steel wire. The findings suggest lower friction means for the self-ligating groups compared with conventional brackets tied with elastomeric ligatures. A more effective frictional control was achieved in the passive self-ligating system when these brackets were tested with no angulation. Under a 2.5° angulation, the frictional force increased in the self-ligating and conventional groups ($p < 0.01$).

ANOVA revealed associations between frictional forces and self-ligating systems. The p value ($p < 0.01$) found using the Bonferroni multiple comparisons test indicated differences between groups (Table 2).

DISCUSSION

Surface friction generated by sliding an orthodontic archwire inside a bracket slot opposes the tendency of tooth movement intended when delivering orthodontic forces. A greater friction effect can be observed in sliding mechanics widely used in first premolar extraction cases, where distalization of canine teeth is recommended. With the purpose of ensuring a correct simulation of clinical conditions, canine brackets were employed. The same brackets were also used in studies conducted by Berger et al[3] and Braun et al.[4]



Figure 3 - Gemini bracket bases filled with resin for subsequent bonding to the surface of metal cylinders. Note how the bases were levelled (filled) with Transbond XT light cure adhesive.

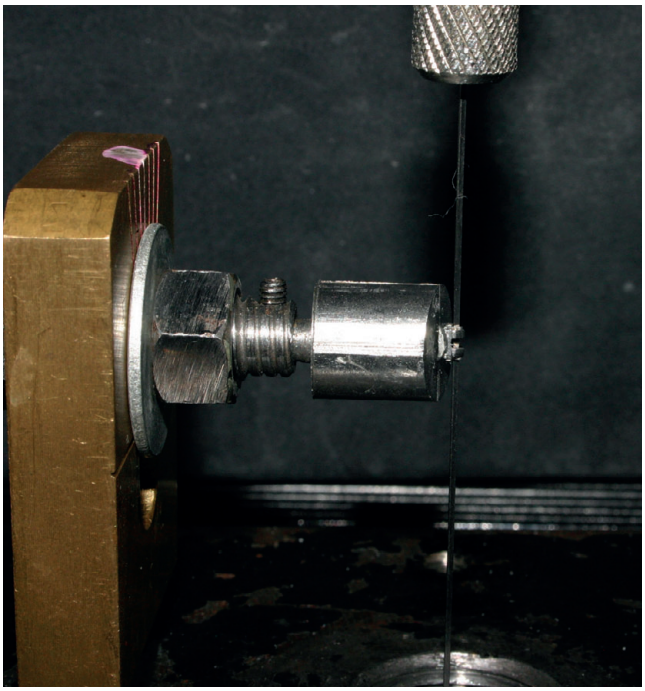


Figure 4 - Stainless steel wires being pulled at an angle of 2.5° while engaged in the slots of Gemini brackets with the aid of gray elastomeric ligatures.

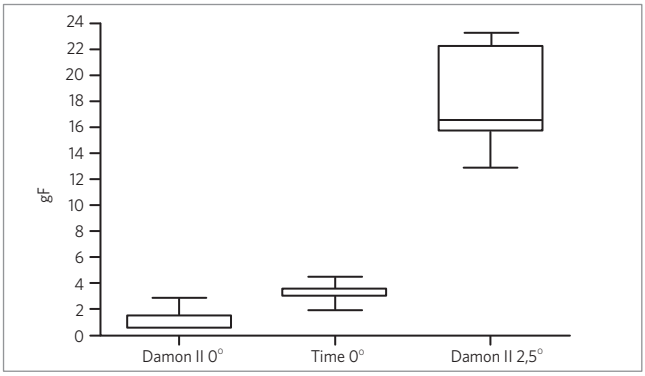


Figure 5 - Distribution of friction values in gram-force (gF) by self-ligating brackets at zero and 2.5° angulation.

Five brackets were tested in each group, with readings being performed at four different points, consecutively to pulling 0.020-in round wires, totaling 20 specimens. This method was applied in order to simulate clinical conditions of sliding mechanics, repeatedly over a distance determined by the treatment goals. The results showed reduced standard deviations, which would render redundant repetitions with the same appliances. Voudoris et al[21] used only eight brackets in each group, totaling twenty-four specimens for each bracket type.[21] Although some authors argue that the surface of brackets and/or wires[11-13] are susceptible to wear, such wear is perhaps more significant in appliances featuring a higher coefficient of friction such as polycarbonate or polycrystalline matrix.

Bracket design and size — as well as bracket angulations and torques[8,14,15] — have a direct relation on friction.[7,8,9,14,15,20] Each manufacturer designs a unique individual self-ligation method. In order to standardize the different prescriptions metal cylinders were fabricated with surfaces that were individually beveled to ensure bondings with no angulations or torques. Authors have used different methods to standardize pre-existing bracket angulations and torques.[4,5,21] Studies conducted by Sims et al[17] also employed metal parts to ensure a parallel positioning of bracket slots relative to orthodontic archwires when bonding the brackets.

Upon selection of canine brackets for use in this experiment it was found that the bases of these brackets were too concave, which might raise a bonding issue. It was necessary to fill the bases with light-cure resin, thereby ensuring each base was levelled to facilitate bonding. Voudoris et al used in their study the same resin filling method and found no variation in friction values as a result of this approach.[21]

Given that tooth sliding is made up of a series of numerous small inclination movements,[6] self-ligating brackets featuring an anterior passive sliding mechanism were subjected to an angulation of 2.5° upon being pulled. Although studies conducted by Read-Ward et al[16] employed up to 10° angulations, angulations above 2.5° produced — in a previous pilot study — force magnitudes which are not viable in clinical practice. Active resilient self-ligating brackets were not angulated due to the inaccuracy likely to be generated during friction. A lack of standardization would occur in the interaction between the flexible bracket cover and the orthodontic wire being tipped, leading to changes in friction at each test. Some authors argue that friction is affected by the features of the surfaces being pulled.[4,6]

One important factor influencing friction magnitude is the ligation method used to engage the orthodontic wire in the bracket slot.[7,18] Currently, the standard ligation system for conventional brackets involves the use of elastomeric ligatures. Metal ligatures produce variable forces according to the technique used by each profissional.[11,21] However, it has been reported that elastomeric ligatures lose some of their elastic capacity when held stretched, which alters any surface friction being generated.[17] In order to limit the number of variables, elastomeric ligatures were changed at every mechanical test.

The results of this study suggest that self-ligating brackets exhibited lower friction values than conventional brackets tied with elastomeric ligatures, as reported in the literature.[2,3,4,14,18,21] The aim of this study was to assess the behavior of brackets with different self-ligation systems tipped at many different angulations. The mean values found for the conventional Gemini system served only as reference and were therefore not treated statistically. In comparing the self-ligating groups statistically when the brackets were pulled with no angulation, the group with brackets equipped with an anterior passive slide mechanism showed greater friction control compared to the active resilient system. This finding is supported by other authors[19] and could be related to a better filling of the bracket slot observed in resilient system, as well as to the pressure exerted by the active cover on the orthodontic wire.

In pulling conventional brackets and self-ligating brackets with a slide mechanism at an angle of 2.5° there was a significant increase in friction compared to the same appliances at 0° angulation. This behavior suggests that there is a direct relationship between angulated traction and surface friction, a relationship that has been observed in other investigations.[1,14,18]

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This study conducted laboratory tests simulating clinical practice as closely as possible. However, tests are limited and often fail to faithfully reproduce the friction generated during clinical procedures. Surface friction values may be different from the forces delivered by intraoral orthodontic systems. Moreover, passive and active self-ligating appliances may differ in terms of clinical significance. The values found in the study should be used only as a yardstick to compare the effects of different types of self-ligating brackets and not to accurately quantify *in vivo* surface friction.

CONCLUSIONS

After assessing passive self-ligating brackets, it was observed that when used at 2.5° of angulation they were less effective in controlling friction than when used under no angulation.

When comparing the self-ligating systems at zero angulation, the hypothesis being tested was confirmed since passive self-ligating brackets proved to be more effective in controlling friction compared to the active system.

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Stability of maxillary anterior crowding treatment

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Objective: To evaluate the stability and the relapse of maxillary anterior crowding treatment on cases with premolar extraction and evaluate the tendency of the teeth to return to their pretreatment position.

Methods: The experimental sample consisted of 70 patients of both sex with an initial Class I and Class II malocclusion and treated with first premolar extractions. The initial mean age was 13,08 years. Dental casts' measurements were obtained at three stages (pretreatment, posttreatment and posttreatment of 9 years on average) and the variables assessed were Little Irregularity Index, maxillary arch length and intercanine. Pearson correlation coefficient was used to know if some studied variable would have influence on the crowding in the three stages (LII1, LII2, LII3) and in each linear displacement of the Little irregularity index (A, B, C, D, E) in the initial and post-retention phases.

Results: The maxillary crowding relapse (LII3-2) is influenced by the initial (LII1), and the teeth tend to return to their pretreatment position.

Conclusion: The results underline the attention that the orthodontist should be given to the maxillary anterior relapse, primarily on those teeth that are crowded before the treatment.

Keywords: Crowding. Angle Class I malocclusion. Angle Class II malocclusion. Corrective Orthodontics.

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How to cite this article: Quaglio CL, Freitas KMS, Freitas MR, Janson G, Henriques JFC. Stability of maxillary anterior crowding treatment. Dental Press J Orthod. 2012 July-Aug;17(4):57-64.

Submitted: April 27, 2009 - **Revised and accepted**: August 19, 2009

» The authors report no commercial, proprietary or financial interest in the products or companies described in this article.

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INTRODUCTION

In the last decades many patients have been seeking orthodontic treatment for esthetics reasons. Orthodontic treatment can improve facial esthetics as well as the occlusion, but long-term stability of the aligned teeth is highly variable and unpredictable. A wide variability of long-term results may be related to the amount of pretreatment crowding, treatment plan, patient's age and cooperation during and after treatment.[22]

For years, many papers on alignment stability researched mandibular anterior crowding, probably because relapse of these teeth are greater than that of the maxillary anterior teeth.[4] More recently, patient's expectation have been considered,[2,9,31] and for the patient, the alignment of the maxillary anterior teeth is especially important, since those teeth are the first to be shown on a smile.[10,22] Since there is greater concern on the esthetics, a small relapse could be a problem. This new scenario obligates the orthodontists to seek out knowledge in order to inform their patients about this problem and to control the risk factors during and after orthodontic treatment.

Most studies have shown that crowding relapse appears to be multifactorial.[10,15] The amount of initial crowding, the arch length, intercanine distance are the most studied factors. There is a consensus about the teeth's tendency to return toward their original position,[1,5,12,14,22] but these studies are, in general, based on arches changes during the orthodontic treatment.

Therefore, in order to seek out for more knowledge on long term stability of maxillary anterior teeth on the orthodontic treatment, this paper evaluates the relapse of the maxillary anterior teeth in cases treated with premolar extractions and their tendency to return toward their original position.

MATERIAL AND METHODS

The sample was selected from the patient records treated in the Department of Orthodontics at Bauru Dental School, University of São Paulo and in the ACOPEN (Assessoria e Consultoria em Ortodontia, Pesquisa e Ensino). To minimize the bias, the sample was selected by inclusion criteria based on the literature[4,10,12,17,19,25,29,30] and on the objective of this study. The selection criteria were patients with all permanent teeth erupted up to the first molars and under 15 years of age at pretreatment (T_1); no supernumerary teeth or tooth agenesis; no fiberotomy or interproximal stripping as part of the treatment plan; Class I or Class II Division 1 malocclusion of, at least, three-forths of a full step Class II molar relationship, no anterior open bite or crossbite and more than 3 mm of crowding on Little's irregularity index[9] in the mandible (LIIMx). The pretreatment (T_1), posttreatment (T_2) and post-retention (T_3) dental casts had to be in good condition to be evaluated. All patients were treated with fixed edgewise appliances and they not underwent rapid maxillary expansion. The patients also had a maximum peer assessment rating (PAR) score of 5 and passive lip seal at posttreatment (T_2). Retention included a maxillary Hawley plate, used it 24 hours per day, for 6 months minimal plus 3 months during sleeping, and a bonded lingual canine-to-canine retainer in the mandibular arch. The post-retention dental casts (T_3) had to be at least 5 years after treatment. The presence of third molars was not part of the inclusion criteria because there is no common sense that have shown these teeth really interfere in anterior crowding relapse.[3,13,20,28]

Therefore, the sample comprised 70 patients, 210 pairs of dental casts (pretreatment, posttreatment and post-retention).

Variable collection method

All dental cast measurements were made with a 0.01 mm precision digital caliper and capacity of 150 mm (Mitutoyo America, Aurora, Ill) by the same examiner. The examiner was blinded in relation to which group did the cast belong to in order to minimize the bias.

The assessed variables:

Little's irregularity index (LII)

The index used to evaluate the mandibular anterior crowding was proposed by Little[18] and named after him. The Little's irregularity index was used because of its great reproductive, precision and it is used in the most studied about crowding and relapse. The variables described by this irregularity index

were adapted to be evaluated on the maxillary arch. This adaptation was used in previous studies.[6,10,21]

In order to measure the amount of crowding a digital caliper was positioned parallel to the occlusal plane. Each linear displacement between the 5 anatomic contact points (A, B, C, D, E) of the anterior teeth were measure (Fig 1). Little's irregularity index comprises the 5 linear displacements added up, which represents the amount of crowding in the anterior teeth.

Arch length (AL)

It is the total distance, in millimeters, from the contact point of the maxillary central incisors to the mesial of the first permanent molars in the right (F) and left side (G) (Fig 2).

Intercanine Width (ICW)

Distance from the cusp tip of the upper canines in millimeters. In cases of cusp wear, the tip was estimated (Fig 2).

Statistical method

All statistical analyses were performed with Statistica software (version 6.0, Statsoft, Tulsa, Oklahoma). Normal distribution was verified by the Kolmogorov-Smirnov test and the results were considered significant when $p<0.05$. The descriptive analysis found the mean, minimum, maximum, standard deviation, the groups and subgroups in all variables studied in the pretreatment (T_1); posttreatment (T_2), post-retention (T_3) casts, as well as, the difference between the posttreatment and pretreatment phase (T_2-T_1) and the post-retention and posttreatment phase (T_3-T_2). The difference between T_2 and T_1 is considered to be treatment changes and the difference between T_3 and T_2 is posttreatment changes.

Method error

The reliability of this study was evaluated by repeated measures of the variables of 15 patients (all phases) randomly chosen. The examiner had a month of interval between the first and the second measurement.

The systematic and casual error were evaluated for each variable. Systematic errors were evaluated with paired *t* tests at $p<0.05$, according to Houston.[16] Casual errors were calculated according to Dahlberg's formula ($Se^2 = Sd^2/2n$).[7]

Statistical analyses

Many studies in the literature are composed with Class I and Class II malocclusions in the same group. In this study, before the Class I and Class II malocclusion joined the same group the compatibility of

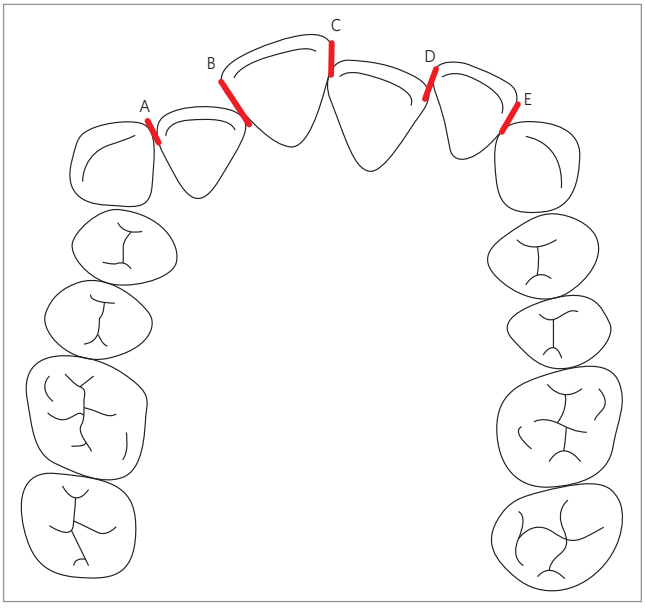


Figure 1 - Little's Irregularity Index for the Upper Arch: Sum of the distances A+B+C+D+E.

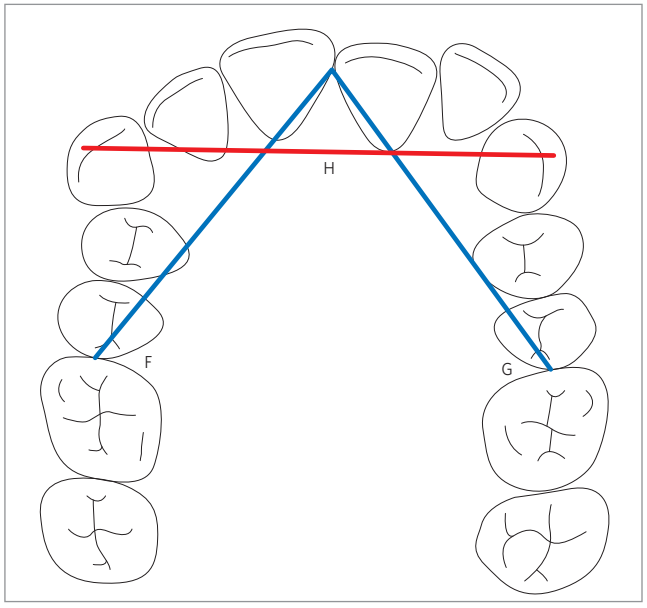


Figure 2 - F+G – arch length; H – intercanine distance.

these two malocclusions was evaluated. The sample was divided into 3 groups: Group 1 (Class I malocclusion treated with 4 first premolar extraction), group 2 (Class II division 1 malocclusion treated with 4 first premolar extraction), group 3 (Class II division 1 malocclusion treated with 2 first maxillary premolar extraction). Intergroup comparisons of all variables were made by one-way analysis of variance (ANOVA). Intergroup sex distribution was evaluated with the chi-square test.

Pearson correlation coefficients were used to assess the relationships between the variables (LIIMx, AL, ICW, posttreatment time and post-retention time). Another evaluation, was the correlation between each linear displacement of Little's irregularity index (A, B, C, D, E). In that way, it was possible to verify the tendency of the teeth to return toward their original position (A1A3, B1B3, C1C3, D1D3, E1D3). The relapse also was evaluated in each linear displacement from Little's irregularity index by using the scores in the pretreatment (T_1) and post-retention (T_3) phases. Any contact point that was correctly adjusted (0 mm), in any one of these phases (T_1 or T_3), was not considered. All other linear displacements were used. The percentages of teeth that kept the same labiolingual direction at T_1 and T_3 were calculated.

The last comparison regarded the severity of the pretreatment crowding. The whole sample was divided in 2 groups (A and B). Group A comprised patients with LIIMx scores less than 7 mm, or minimal and moderate irregularity (19 patients), while group B had LIIMx scores equal to or greater than 7 mm, or severe and very severe irregularity (51 patients). The ratio between the post-retention changes (LIIMx3-2) and the correction amounts (LIIMx2-1) was called the relapse percentage. The absolute score of the correction amounts was used. The posttreatment changes that had negative scores (a greater alignment of the contact point) was considered to be zero.

RESULTS

Method error

Variables showed casual error smaller than 1 mm. Among all 30 variables, only width D at T_2 showed a significant systematic error (96% precision).

Statistical analises

The table 1 and 2 show the compatibility between the 3 groups regarding variables (Tab 1) and gender (Tab 2).

The table 3 shows the mean, minimum, maximum, standard deviation and total sample. Pearson correlation coefficients were used to assess the relationships of LIIMx scores at different stages with the other variables (Tab 4). There was a positive correlation between LIIMx1 x LIIMx3, LIIMx1 x LIIMx3-2 and LIIMx2 x LIIMx3. There was a negative correlation between LIIMx2-1 x LIIMx3-2. Table 5 shows the correlation between the linear distance in the post-retention (T_3) and pretreatment (T_1) phase in B, C and D.

The sample consisted of 70 patients, each patient had 5 anatomic contact points described by Little[18] (Fig 1); totalling of 350 contact points. In the pretreatment phase, there were 309 linear displacements for labiolingual direction. The amount of linear displacement in post-retention phase was verified at the same contact points of the 309 linear displacements in pretreatment. The total of linear displacement in post-retention phase was 184. These 184 linear displacements were used to evaluate the tendency that a tooth had to return toward its original position. A total of 142 anatomic contact points in the pretreatment phase had the same labiolingual direction in the post-retention phase. These results have shown that 77% of the labiolingual linear displacement had the tendency to return toward their original position.

The total sample was divided in group A (LIIMx1 < 7 mm) and group B (LIIMx1 > 7 mm) in order to evaluate the pretreatment severity crowding with the relapse percentage. The paired *t* test did not show a significant difference among these variables (Tab 6).

DISCUSSION

Groups 1, 2, 3 were compatible regarding all variables (Tab 1 and 2), therefore the total sample (70 patients) could be evaluated. The maxillary anterior crowding relapse (LIIMx3-2) of the total sample was 1.07 mm (Tab 3). Since the percentage is the easiest way to visualize a result, there was an 11.88% of maxillary anterior crowding relapse. This percentage was the result from the posttreatment changes

(LIIMx3-2) divided by the treatment changes (LIIMx2-1) multiplied by 100. Others studies in the orthodontic literature had similar results[10,11,15,21,22]. Our result showed a great stability of the maxillary anterior alignment, 88,12%.

Pearson correlation test was used to assess the relationships of LIIMx scores at different stages with the other variables. There was a significant positive correlation between Little's irregularity index at pretreatment (LIIMx1) and the posttreatment changes (LIIMx3-2). This result shows that pretreatment maxillary anterior crowding is correlated with the posttreatment maxillary anterior crowding (Tab 4), and this is supported by previous studies that have shown that pretreatment maxillary anterior crowding interfere in the crowding relapse.[1,8,24]

The posttreatment Little's irregularity index (LIIMx2) has a significant positive correlation with the post-retention Little's irregularity index (LIIMx3). The posttreatment changes (LIIMx3-2) did not show a significant correlation with the amount of posttreatment crowding (LIIMx2) (Tab 4). Both results must be analyzed together because the crowding relapse would be influenced by quality of treatment results (LIIMx2) only if there was a significant correlation between the amounts of posttreatment crowding (LIIMx2) and the posttreatment changes. Many previous studies, even

Table 1 - Intergroup comparisons (1-way ANOVA).

Variable	Group1 Class I, 4 extractions		Group 2 Class II division 1, 4 extractions		Group 2 Class II division 1, 2 extractions		p
	Mean	S.D.	Mean	S.D.	Mean	S.D.	
Pretreatment (T_1) age (y)	13.16^A	0.97	12.95^A	1.08	13.09^A	1.11	0.760
Posttreatment (T_2) age (y)	15.15^A	1.14	15.43^A	1.28	15.14^A	1.10	0.604
Post-retention (T_3) age (y)	23.71^A	2.80	24.97^A	4.02	25.02^A	2.85	0.159
Posttreatment assessment	8.55^A	3.03	9.54^A	4.27	9.88^A	2.87	0.209
Post-retention assessment	7.31^A	3.18	8.26^A	4.47	8.78^A	2.95	0.191
LII_1	8.59^A	3.08	11.10^A	4.46	9.68^A	4.00	0.077
CAS_1	71.04^A	3.79	70.48^A	4.38	69.88^A	3.63	0.590
$DICS_1$	34.78^A	2.25	34.56^A	2.81	34.49^A	2.90	0.917
LII_2	0.80^A	0.90	0.61^A	0.52	0.64^A	0.55	0.601
CAS_2	62.05^A	2.20	62.91^A	1.96	61.06^A	2.98	0.096
$DICS_2$	34.73^A	1.75	35.59^A	2.00	34.72^A	1.55	0.194
LII_3	1.79^A	1.59	2.07^A	1.44	1.43^A	1.03	0.361
CAS_3	60.66^A	2.26	61.40^A	3.59	60.13^A	3.01	0.381
$DICS_3$	34.58^A	1.58	35.03^A	1.97	34.87^A	2.22	0.689
LII_{3-2}	0.97^A	1.28	1.46^A	1.42	0.79^A	1.05	0.223
CAS_{3-2}	- 1.39^A	1.37	- 1.50^A	2.47	- 0.93^A	1.36	0.544
$DICS_{3-2}$	- 0.16^A	1.02	- 0.56^A	1.15	0.15^A	1.30	0.155

Table 2 - Intergroup comparison of gender distribution (chi-square test).

Gender	Group 1 Class I, 4 extractions	Group 2 Class II division 1, 4 extractions	Group 2 Class II division 1, 2 extractions	Total
Male	12	11	11	34
Female	18	9	9	36
Total	30	20	20	70
chi-square=1.544 df = 2 P= 0.462				

Table 3 - Descriptive analysis of the sample.

Variable	Sample N =70			
	Mean	Minimun	Maximun	S.D
LIIMx1 (mm)	9.62	3.21	20.38	3.87
LIIMx2 (mm)	0.70	0.00	3.44	0.71
LIIMx3 (mm)	1.77	0.10	6.87	1.41
LIIMx2-1 (mm)	-8.92	-19.48	-2.94	3.77
LIIMx3-2 (mm)	1.07	-1.44	4.40	1.27
LIIMx3-1 (mm)	-7.85	-18.57	-1.85	3.61
Pretreatment (T_1) age (y)	13.08	10.63	15.02	1.03
Pretreatment (T_1) age (y)	15.23	12.14	17.55	1.61
Pretreatment (T_1) age (y)	24.44	18.84	33.11	3.22
Post-retention observation (y)	9.21	5.00	17.23	3.39

Table 4 - Pearson correlation test.

Variable	R	p
LIIMx1 x LIIMx2 (mm)	0.2227	0.064
LIIMx1 x LIIMx3 (mm)	0.3596	0.002*
LIIMx1 x LIIMx3-2 (mm)	0.2698	0.024*
LIIMx2 x LIIMx3 (mm)	0.4380	0.000*
LIIMx2-1 x LIIMx3-2 (mm)	-0.2921	0.014*
LIIMx3 x LIIMx3-2 (mm)	-0.0832	0.494
LIIMx3x AL3 (mm)	0.0449	0.712
LIIMx3 x ICW3 (mm)	-0.0973	0.423
LIIMx3 x Posttreatment observation (mm)	0.1160	0.339
LIIMx3 x Pretreatment age (y)	0.0929	0.444
LIIMx3 x Posttreatment age (y)	-0.0035	0.977
LIIMx3 x Post-retention age (y)	0.1207	0.319
LIIMx3-2 x AL3-2 (mm)	0.0557	0.647
LIIMx3-2 x ICW3-2 (mm)	-0.1371	0.258

*p< 0,05%.

Table 5 - Pearson correlation test between the variables A, B, C, D, E in the post-retention (T_3) and pretreatment (T_1) phases.

Variable	R	p
A3 x A1 (mm)	0.1504	0214
B3 x B1 (mm)	0.4586	0.000*
C3 x C1 (mm)	0.3592	0.002*
D3 x D1 (mm)	0.4977	0.000*
E3 x E1 (mm)	0.0386	0.751

*p< 0,05%.

Table 6 - Paired t test between the pretreatment severity crowding with the relapse percentage.

Variable	Group A Severity <7 mm	S.D.	Group B Severity >7 mm	S.D.	p
Pretreatment age (y)	15.41	12.12	12.40	16.86	0.068

though being about mandibular anterior crowding, corroborated with this study.[22,23,24] The positive significant correlation between posttreatment Little's irregularity index (LIIMx2) and post-retention Little's irregularity index (LIIMx3) is that posttreatment crowding is, at least, the same after a long-term evaluation.

Changes during treatment (LIIMx2-1) had a significant correlation with the post-retention changes (LIIM x 3-2) (Tab 4). Despite this negative correlation, it is considered to be a false negative. Since LIIMx2-1 has a negative sign (posttreatment crowding minus pretreatment crowding) and the variable LIIMx3-2 has a positive sign (post-retention crowding minus pretreatment crowding); when these two variables are correlated, the negative sign is maintained as a positive correlation result.

The post-retention crowding (LIIMx3) was evaluated with the posttreatment arch length and intercanine width (AL3, ICW3), posttreatment observation and age in all phases. These variables were chosen because the literature presented some studies with significant positive correlation between the post-retention crowding (LIIMx3) and these variables[1,27,30] (Tab 4). None of these variables was significantly correlated.

The Pearson correlation coefficients were used to assess the relationships between linear displacements of the anatomic contact points at T_1 and T_3. The percentages of teeth that kept the same labiolingual direction at T_1 and T_3 were calculated. There were significant positive correlations among linear displacements of anatomic contact point B (mesial surface of maxillary right lateral incisor with distal surface of maxillary right central incisor), contact point C (mesial surface of maxillary right central incisor with distal surface of maxillary left central incisor), and contact point D (mesial surface of maxillary left lateral incisor with distal maxillary left central incisor) at T_1 and T_3 (Tab 5). These small proximal surfaces could cause a weak contact point which could increase susceptibility of misalignment over the years. The literature has not evaluated the recurrence of crowding the way our study has, in each region of the Little Index (A, B, C, D and E), so our study should not be compared directly with any study published.

The literature has showned the teeth tendency to return to its original position by evaluating rotation or only by the assuming when there was a statistical correlation between total relapse and initial crowding.[1,8,22,24,30] If the Little's irregularity index is evaluated carefully, it does not show the teeth tendency to return to their original position. The Little's irregularity index is the sum of 5 displacements (A, B, C, D, E) and it does not evaluate the direction of each anterior tooth in relation to its adjacent teeth (labial or lingual). To answer this question the models were evaluated again taking into consideration the labiolingual direction in the pretreatment phase (T_1) and in the post-retention phase (T_3). From the 309 regions that showed labiolingual displacement in pretreatment phase, 184 regions showed labiolingual displacement in post-retention phase. There were 142 regions in post-retention phase that had the same pattern of displacement. This means that around 77% of the regions had the same pattern of displacement over the years, showing that the teeth have a tendency to return to the original position.

The significant correlation has shown that the pretreatment crowding pattern has some influence in posttreatment crowding, but this correlation does not show if the pretreatment crowding pattern has influence in posttreatment crowding percentage, or in other words: "Does the teeth with greater pretreatment crowding tend to have more crowding relapse and vice-versa?" To answer this question the total sample was divided into two groups: Group A with moderate crowding (4-6 mm), and Group B with severe and very severe crowding (from 7 mm).[18] The comparison of the posttreatment crowding percentage between these two groups showed no significant difference (Tab 6). This result does not show an influence of the pretreatment crowding on the crowding relapse percentage, even though the mean of the crowding relapse percentage of the Group A (severity > 7 mm) was greater that crowding relapse percentage of the Group B (severity < 7 mm). A similar study with this comparison showed significant diferrences.[12] That could be explained by the 8th Riedel's theorem[26] which states that the further teeth have been moved, they are less likely to relapse. Therefore, the relationship between the pretreatment crowding and the posttreatment crowding relapse might exist but this relationship should be carefully used when it comes to the pretreatment crowding severity and posttreatment relapse. It means that 2 mm of posttreatment crowding in a case with 4 mm of pretreatment crowding is 50% of relapse, but 4 mm of posttreatment crowding in a case with 12 mm of pretreatment crowding is 33% of relapse. The amount of relapse shows that the case with the greater amount of pretreatment crowding had a greater relapse, but the percentage was lower.

Final considerations

Nowadays the patient is concerned about having an esthetic smile so many orthodontic treatments are aimed in correcting crowding. The increased demand for orthodontic treatment is a positive fact to the orthodontists but they cannot forget that the teeth appears to have a posttreatment "agenda". Orthodontists have to be more careful in cases where the patients seek treatment only to align a tooth that bothers him. After treatment and over the years, the same tooth could be back to a similar position. To avoid any failure, the orthodontist must be stringent in correcting this irregularity and on the retention plan. The patient has to be aware of the treatment and the posttreatment risks.

CONCLUSION

- The stability of maxillary anterior alignment in the whole sample was 88.12%, in an average of 9 years of posttreatment.
- There was a significant positive correlation between the amounts of pretreatment maxillary anterior crowding and the maxillary anterior relapse. The greater was the amount of pretreatment crowding, the greater was the relapse.
- The maxillary anterior teeth tend to return to their original positions.

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Maxillary incisors mesiodistal angulation changes in patients with orthodontically treated anterior superior diastemas

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Objective: The aims of this study were to describe the patterns of maxillary incisor angulation in patients with upper interincisive diastemas, to evaluate angulation changes with treatment and posttreatment period, and to assess whether there are association between incisor angulation and interincisive diastema relapse.

Methods: The sample comprised 30 Class I or Class II patients with at least one pretreatment anterior diastema of 0.77 mm or greater after eruption of maxillary permanent canines. Data were obtained from panoramic radiographs at pretreatment, posttreatment and at least 2 years post-retention.

Results: Incisors presented a mesial tipping tendency after treatment, but only lateral incisors showed significant changes between pre and posttreatment stages.

Conclusion: Regarding post-retention period, no changes were found. Finally, no relation was found between diastema relapse and maxillary incisor axial angulation.

Keywords: Angulation. Diastema. Stability. Panoramic radiograph. Orthodontics.

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How to cite this article: Morais JF, Freitas MR, Freitas KMS, Janson G, Branco NCC, Zanda M. Maxillary incisors mesiodistal angulation changes in patients with orthodontically treated anterior superior diastemas. Dental Press J Orthod. 2012 July-Aug;17(4):65-71.

Submitted: April 29, 2009 - **Revised and accepted:** October 22, 2009

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

» The authors report no commercial, proprietary or financial interest in the products or companies described in this article.

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INTRODUCTION

Mesiodistal angulation of teeth may influence the harmony of the smile and the posterior occlusion.[4] Furthermore, orthodontic finishing with parallel roots promotes correct occlusal force distribution and contributes for treatment stability.[9]

Depending on the amount of mesiodistal tipping, the space occupied by a tooth can be altered, modifying the arch length or filling previous spacing. This association is more perceptible in the maxillary anterior segment due to the longer crown shapes compared to the buccal crown shapes.

The ideal root mesiodistal positioning is still dubious in the literature. Some authors defend that finishing with parallel roots reduces the risk of space reopening after space closure mechanics.[9,10,20] Andrews[4] determined average values for each tooth angulation based on normal occlusion patients and asserted that those values should be aimed when treating orthodontic patients. On the other hand, it was cited that positioning the maxillary central incisors with more divergent roots improve median diastema closure stability.[17]

It is well-known that during the development of occlusion the maxillary incisors exhibit divergent crowns and generalized spacing. These spaces are normally closed spontaneously and the incisors become more mesially tipped.[8] However, a prevalence ranging from 1.7 to 38% of patients remains with anterior spacing during permanent dentition.[14,16,23,25,29]

One of the most common treatment approach of maxillary anterior spacing is closing the spaces by orthodontic movement.[2,5,12,13,24] Yet there is evidence that orthodontic closure of median diastema is not stable out of retention[10,24,26] (Fig 1). Among the possible contributing factors for diastema relapse is the incisor root mesiodistal positioning.

Few studies evaluated changes in teeth angulations during and after orthodontic treatment.[1,7] But changes in incisor angulations specifically in patients with maxillary anterior spacing was still not assessed.

Therefore, the objective of this study was to describe the mesiodistal angulation pattern of the maxillary incisors in patients with anterior spacing and evaluate changes in the incisor angulations during treatment and after retention. Additionally, we aim to analyze whether there is association between incisor angulations at pretreatment, post-treatment and post-retention stages, and maxillary anterior spacing relapse.

OBJECTIVE

The aim of this study was to describe the mesiodistal angulation pattern of the upper incisors in patients with diastema in this area and observe the alteration of this angulation during the orthodontic treatment and after removing the upper retention. Also, verify whether there is an association between the mesiodistal angulation of these teeth in the initial and final stages of treatment and the post-retention and the anterior superior diastema relapse.

MATERIAL AND METHODS

Material

The subjects evaluated in this study were selected from the files of the Orthodontic Department at the University of São Paulo, which comprised 4334 patients. Inclusion criteria comprised maxillary interincisor diastema equal to or greater than 0.77 mm, after partial eruption of the maxillary canines. Subjects with missing anterior teeth, periodontal disease with bone loss, generalized microdontia, maxillary pathologies, mesiodens, diastema closure by a non-orthodontic method and post-orthodontic restoration of maxillary anterior teeth resulting in increase in mesiodistal width were excluded.

Ninety panoramic radiographs of 30 subjects (13 male and 17 female) taken at pre-treatment (T_1), post-treatment (T_2) and post-retention (T_3) stages



Figure 1 - Example of anterior superior diastema relapse. Photograph obtained 10 years after removing the superior Hawley retainer.

were selected. All patients were treated nonextraction. Eighteen subjects showed a Class I and 12 of them showed a Class II malocclusion. Maxillary canines were completely erupted in 20 patients. The average initial age was 12.94 years (SD 1.27) and the treatment time was 2.38 years (SD 1.06). The retention time and the period between the appliance removal and the last follow-up appointment were 1.44 (SD 0.48) and 7.05 (SD 3.60) years, respectively.

Methods

Measurements of spaces between maxillary central and lateral incisors were taken on dental casts taken at T_1, T_2, and T_3 with a 0.01 mm precision digital caliper (Mitutoyo, Japan). Widths were considered to be the smallest distance between adjacent teeth at the gingival level (Fig 2). The sum of the maxillary interincisor widths at post-treatment (T_2) and post-retention (T_3) stages were obtained. The space relapse was calculated by subtracting the sum of the spaces at T_3 minus the sum of the spaces at T_2. According to this result, the sample was divided into two groups stable and unstable. Unstable cases occurred when the result was greater than zero.

Panoramic radiographs of 24 patients were taken with a Rotograph Plus unit (Villa Sistemi Medicali, Italy) which shows a mean linear magnification of 25%. While six patients had their pretreatment and post-treatment panoramic projections taken with as Orthophos CD unit (Siemens Medical Systems, Germany), which presents a mean linear magnification of 27%.

The panoramic radiographs were traced by the same examiner using a 0.5 mm pencil on a sheet of acetate paper (14 x 21 cm) placed over the radiographic film. The inferior outline of the orbits, the inferior outlines of the zygomatic processes of the maxilla and the contours of the maxillary incisors were traced. The horizontal reference lines used were interorbital (IO), passing through the most inferior point of the right and left orbits, and the interzygomatic processes of the maxilla (IZP), passing through the most inferior point of the right and left zygomatic processes of the maxilla. Each incisor long-axis was traced determined by its pulp canal long-axis (Fig 3).

The analyzed variables were: RLI (angle between the long axis of the right lateral maxillary incisor and the IZP line), RCI (angle between the long axis of the right central maxillary incisor and the IZP line), LCI (angle between the long axis of the left central maxillary incisor and the IZP line), and LLI (angle between the long axis of the left lateral maxillary incisor and the IZP line).

In this study, the IZP line was used because only twenty patients presented both orbital inferior contours in the panoramic radiographs of the initial, final and follow-up stages. The angle IO.IZP between the IO and the IZP reference lines was evaluated in

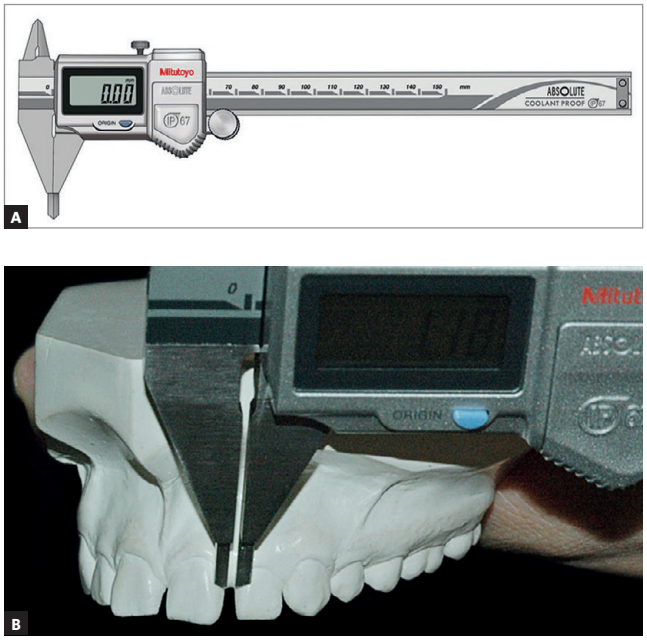


Figure 2 - **A**) Digital caliper Mitutoyo used to measure interincisor spacing. **B**) Diastema measurement method.

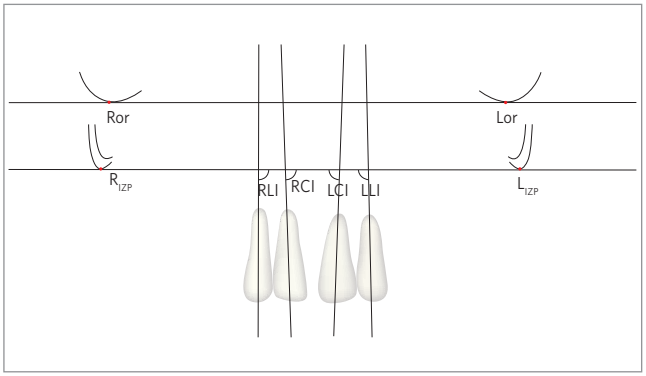


Figure 3 - Schematic design of the radiographic tracings performed showing the orbital contours, zygomatic processes of maxilla, contour of maxillary incisors, as well as the reference lines interorbitary (IO), interzygomatic processes (IZP), and teeth long axes.

twenty patients where the orbital contours could be traced. When the lines converged at the right side the values were written positive, while when the convergence occurred at the left side the values were written negative.

Statistical analyses

Thirty panoramic radiographs were retraced and remeasured by the same examiner after a month interval. The casual error was calculated according to Dahlberg's formula.[2] The systematic errors were analyzed with a *t* test[16] at $p<0.05$.

Mean values and standard deviations of each maxillary incisor angulations were calculated at the initial (T_1), final (T_2), and post-retention (T_3) stages and were compared by repeated measures ANOVA, followed by Tukey post hoc test, in order to evaluate the changes occurred during treatment (T_1 and T_2), to analyze the stability of treatment outcomes (T_2 and T_3) as well as to verify if the angulations after retention and before treatment were similar.

Since the patients evaluated are in growing phase, repeated measures ANOVA, followed by Tukey tests, were used to assess the changes in the parallelism between IO and IZP lines.

Student's *t* tests were used to compare mesiodistal angulations between the stable and unstable groups at T_1, T_2 and T_3.

RESULTS

Method precision

The casual error was found to be small and acceptable for all measurements, while the systematic error was not statistically significant for any measurement (Tab 1).

The angle between the IZP and IO lines with a maximum divergence of 2° at all stages (Tab 2) demonstrates an acceptable parallelism between these lines.

Incisor angulations showed a tendency for mesial inclination during orthodontic treatment but the changes were significant only for lateral incisor angulations (Tab 3). On the other hand, all incisor angulations remained stable during post-retention period.

No differences were found between stable and unstable groups (Tab 4). This suggests that there was no association between space relapse and mesiodistal angulations.

ANOVA and Tukey test results

Generally, the angulation of the incisors presented a tedency to mesialization with orthodontic treatment, and there was a significant difference only for the lateral incisors angulation (Tab 3). In the postretention stage, the angulation of all incisors remained stable.

Angulation comparison between stable and non-stable groups

No significant difference was verified between groups (Tab 4). This fact suggests that there was no relation between diastemas relapse and mesiodistal angulations.

DISCUSSION

Since the development and improvement of the panoramic radiograph technique by Paatero,[18,19] it has been recognized as an essential diagnosis method because it is possible to show on the same film the whole dentition, alveolar bone, temporomandibular joint and adjacent structures. Additionally, panoramic radiographs help the evaluation of mesiodistal teeth angulations before and after treatment[1,11,15,30] and root parallelism near extraction areas.[11,15]

Table 1 - Method error for repeated measurements.

	1st measurement		2nd measurement		Systematic error	Casual error	n
	Mean	SD	Mean	SD	p	Dahlberg	
LLI	96.89	4.95	95.59	4.28	0.597	1.45	30
LCI	89.72	3.29	89.88	3.55	0.589	1.38	30
RCI	87.96	3.89	87.71	2.39	0.781	1.29	30
RLI	96.43	5.19	95.92	5.01	0.498	1.37	30
IO.IZP	0.07	0.90	0.07	0.95	0.988	0.17	20

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Table 2 - Descriptive statistics and repeated measures analysis of variance comparing the angle between interorbitary and inter-zigomatic processes of maxilla in initial, final, and postretention stages.

	Total (3 stages) N=20				Initial (T_1) N=20		Final (T_2) n=20		Post-retention (T_3) n=20		ANOVA p
	Mean	SD	Min	Max	Mean	SD	Mean	SD	Mean	SD	
IO.IZP	0.07	0.90	-2.0	2.0	0.08	0.95	0.03	0.64	0.13	1.10	0.94

Table 3 - Results of repeated measures analysis of variance, followed by Tukey tests comparing mesiodistal angulations of each incisor at all stages T_1, T_2 and T_3.

	LLI		LCI		RCI		RLI	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Initial (T_1)	98.37^{A}	4.47	90.70	3.26	89.33	3.90	97.12^{A}	5.05
Final (T_2)	96.55^{AB}	5.36	89.32	3.36	87.68	3.76	94.25^{B}	5.30
Post-retention (T_3)	95.08^{B}	4.28	89.18	3.31	87.67	3.40	93.90^{B}	3.16
p (ANOVA)	0.031*		0.151		0.139		0.015*	

* statistically significant for p<0,05.

It is known that panoramic radiographs as well as any extraoral radiograph exhibit magnification of the real image.[3,6] But in panoramic radiographs the amount of magnification varies in different sites of the film due to the method of image acquisition by moving the X-ray tube. The linear measurements, especially horizontal ones, demonstrate significant magnification and are not reliable. In the other hand, angular measurements exhibit smaller distortions[6,11,15,22], specially on the anterior region,[3,21] confirming that panoramic radiographs can be a reliable method to evaluate angular measurements on maxillary anterior teeth.

It is traditionally advocated that appropriate root parallelism improves treatment stability,[9,10,20] especially in the areas of space closure after extractions.[9,20] In cases with anterior spacing, the incisor mesiodistal positions has been mentioned to influence stability,[10,17] even though there is no study evaluating the mesiodistal angulations of maxillary anterior teeth in cases with interincisor diastema.

Some studies[1,7,28,30] have evaluated teeth angulations with panoramic radiographs, using the interorbital line (IO) as reference. Nevertheless, in our study, ten patients did not show both orbital inferior contours in the panoramic radiographs of the initial, final and follow-up stages. Therefore, the zygomatic processes of the maxilla were traced so that interzygomatic processes of the maxilla (IZP) line, similar to IO line, was used. The results showed an acceptable parallelism (Tab 2) and a maximum divergence of 2° between these lines. This demonstrates that the IZP line can be as reliable as the interorbital line and the values obtained in this study can be compared to those proposed by Ursi[30] obtained from patients with normal occlusion.

Table 4 - Results of Student t tests comparing the incisor angulations in each stage T_1, T_2, and T_3 between the groups stable and unstable.

	Stable (n=14)		Unstable (n=16)		p
	Mean	SD	Mean	SD	
LLI-T1	98.36	5.02	98.38	4.11	0.992
LCI-T1	91.89	3.11	89.66	3.10	0.059
RCI-T1	89.75	3.37	88.97	4.39	0.593
RLI-T1	96.21	5.79	97.91	4.33	0.369
LLI-T2	96.36	6.96	96.72	3.69	0.858
LCI-T2	89.54	4.30	89.13	2.38	0.744
RCI-T2	87.29	4.12	88.03	3.50	0.596
RLI-T2	93.21	6.53	95.16	3.95	0.326
LLI-T3	95.25	3.91	94.94	4.70	0.846
LCI-T3	88.86	3.41	89.47	3.30	0.622
RCI-T3	87.54	4.02	87.78	2.88	0.847
RLI-T3	93.68	3.61	94.09	2.80	0.726

According to repeated measures analysis of variance (Tab 3), the changes in the maxillary central incisors angulations were not significant during (T_1-T_2)

and after treatment (T_2-T_3), except for the lateral incisor angulations, which showed significant changes in both periods. There was a tendency for crown mesialization, which may be explained by the mechanics used, which included an association of preadjusted appliances with elastomeric chains. The high forces produced might cause great crown mesialization if used on light wires (Fig 4).

The mesiodistal angulations achieved with treatment remained stable (Tab 3). These findings shows that finishing with ideal angulations should be a relevant treatment objective, since the patient's smile will show the positions obtained, even after a long period out of retention.

Diastema relapse is quite often on maxillary anterior area.[10,24,26,27] Some authors reported that space reopening might be associated with an inappropriate root positioning at the end of treatment. However our results showed no difference between stable and unstable groups in central and lateral incisor angulations when compared in each initial, final, post-retention stages. In conclusion, this demonstrates that no association between space reopening and mesiodistal angulations was found.



Figure 4 - Effect of crown mesialization induced by elastomeric chain.

CONCLUSIONS

Based on the method and the results we conclude:

1) Incisor mesiodistal angulations in patients with anterior spacing showed slight changes during treatment with greater crown mesialization on the lateral incisors, which remained stable posttreatment.
2) There was no association between anterior spacing relapse and mesiodistal angulations of the maxillary incisors.

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Microbiological evaluation of bristles of frequently used toothbrushes

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Introduction: Brushing teeth is probably the practice of oral hygiene most common in the world; however, inadequate use can become a risk to the population health, once they may be contaminated with various microorganisms.

Objective: The aim of this study was to evaluate the bacterial contamination on toothbrush bristles using different methodologies.

Method: We used 40 toothbrushes from healthy individuals aged 3 to 58 years. The samples were grown in test tubes containing trypticase soy broth sterile, and with the help of a tracking 0.1 µl samples were placed on plates containing sheep blood agar 5% and MacConkey agar then the samples were stored in a bacteriological incubator at 37°C for 24 hours for later analysis. It was counted the colony forming units and bacteria identification present in the brush.

Results: On the microbiological analysis, there was a growth of *Escherichia coli*, *Klebsiella pneumoniae*, *Streptococcus pyogenes* and *Staphylococcus coagulase* negative.

Conclusion: According to the results presented in this study, we observed a high incidence of bacterial contamination in the brushes analyzed. The most frequent microorganisms were members of the Enterobacteriaceae. The usage time of toothbrushes may be related to contamination found and, therefore, not only good hygiene ensures the reduction of microbial load, but replacing the toothbrush can also ensure individuals better oral health.

Keywords: Toothbrushing. Contamination. Oral hygiene.

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How to cite this article: Ferreira CA, Savi GD, Panatto AP, Generoso JS, Barichello T. Microbiological evaluation of bristles of frequently used toothbrushes. Dental Press J Orthod. 2012 July-Aug;17(4):72-6.

Submitted: December 25, 2009 - **Revised and accepted:** October 5, 2011

» The authors report no commercial, proprietary or financial interest in the products or companies described in this article.

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INTRODUCTION

One of the biggest public health problems of most developing countries concerns the reduction or elimination of periodontal disease and caries, even with significant prevalence in the population, related indirectly to factors such as financial, housing, culture level and eating habits.[1] The toothbrush is the only instrument that the majority of the population has to control the dental biofilm[2]. Brushing is probably the oral hygiene practice most commonly performed in the world. The first brushes were made of pig fur and bristles made of horse mane or tail mounted in bovine bone or ivory.[3] This tool has as main function the reduction of dental plaque that may be responsible for oral diseases including dental caries, periodontal disease and halitosis.[13] Toothbrushes must present minimum requirements for the plaque removal such as: the bristles should be stiff enough to remove biofilm without causing trauma to the teeth and gums (optimized by rounding the active end of the bristles) and the head should be small with soft bristles.[17] Another point of concern, is the fact that toothbrushes can be a source of contamination within users,[13] through direct contact of different brushes from family members, or contamination from the containers that are usually moistured on the sink or in bathroom cabinets.[6,10] Toothbrushes become rapidly contaminated with oral microorganisms, including bacteria, viruses and fungi.[20] The oral cavity presents one of the most concentrated and varied microbial populations,notably colonized by Staphylococcus sp, Streptococcus sp., Neisseria sp, Bacteroides sp, Actinomyces sp, Treponema sp, Mycoplasma sp.[19] These microorganisms can colonize the oral cavity, and also the environment where the toothbrushes are stored.[21] In addition, organisms normally associated with the oral flora have been isolated from toothbrushes, including the family Enterobacteriaceae[20] and its origin is probably the bathroom.[21] The toothbrush should be sanitized or disinfected and replaced in regular time periods. In this context, studies of microbial contamination of toothbrushes *in vivo*, proposing methods for its sanitation or disinfection,[3] have emerged over the last two decades Many consumers buy less than a toothbrush for year despite recommendations made by dentists, where a toothbrush must be used for a maximum period of three months. The brushes can become less effective for removing plaque compared with a new toothbrush, yet consumers are usually reluctant to replace the brushes more frequently.[3,24] This present study aimed to evaluate the microbiological contamination of toothbrush bristles in continuous use, using two different methods.

MATERIALS AND METHODS

Sample collection

The samples were randomly collected from apparently healthy individuals. The inclusion criteria were: 1) free age, 2) used the toothbrush at least three times a day; 3) the duration of use was over a month. Were excluded from the study subjects who had one or more of the following criteria: 1) bleeding gums and mouth, 2) dental post surgery 3) hospitalized subjects. The number of samples used comprised of 40 frequently used toothbrushes. The average use of toothbrushes in four participants was 3 months, in 9 participants was 5 months of use, in seven subjects was 1 month and 20 participants was 7 months of use. These brushes were collected aseptically in a sterile container and send immediately to the microbiology laboratory at the University of the Extreme South of Santa Catarina for microbiological analysis of the bristles.

Microbiological processing

For the analysis two different methodologies were used. The first method was developed by Cleri, Corrado and Seligman[5]: 20 toothbrushes were placed in test tubes containing 5 mL of tryptic soy broth (TSB). Sterile tubes were homogenized three times added l0.1µl loop and plated on sheep blood agar containing 5% and MacConkey agar. The plates were stored in a bacteriological incubator at 37 ° C for a 24 hours period for microbial growth analysis. The second method was developed by Sherertz, Raad and Balani[22]: 20 toothbrushes were placed individually in a test tube containing 5 mL of tryptic soy broth (TSB), then the samples were homogenized for 15s with vortex. The brushes were removed from the culture medium and passed through 0.05 mL to 5 mL of sterile TSB broth with a micropipette, resulting in a dilution of 1:100.

This broth was homogenized again and with addition of a 0.1 mL loop was streaked on plates containing sheep blood agar and 5% MacConkey agar. The plates were stored in a bacteriological incubator at 37° C for a period of 24 hours for microbial growth analysis. After 24h growth the colony-forming units (CFU) were counted and subsequent microorganisms identification. For the microorganisms identification was performed Gram stain and biochemical tests.

RESULTS

According to the methodology of Cleri, Corrado and Seligman,[5] in the present study the results showed that there was contamination in 14 samples totaling 70%. In the remaining 30% there was no microbial growth. The bacteria identified in the seeded culture media growth were Escherichia coli with 45%, followed by Klebsiella pneumoniae 35%, Streptococcus pyogenes and Staphylococcus coagulase negative with 10%, as shown in Table 1. Table 2 shows the frequency of colony-forming units (CFU), in which 30% of samples were considered negative and there were no growth in plates containing culture media. Moreover, 25% of the sample had an average of 220500 CFU/mL, 20% 367500 CFU/mL, 15% 514500 CFU/mL and 10% 661500 CFU/mL totaling 70% with microbial growth. In Figure 1, it is seen an exponential growth in the number of bacteria related to the time of toothbrushes use, and increased toothbrushes contamination in accordance with its longer usage. In the second method mentioned by Sherertz, Raad and Balani,[22] was detected microbial growth in just five toothbrushes totaling 25% of the samples and on 15 brushes the result was an absence of growth in total percentage of 75%. Table 3 shows the microorganisms found, Escherichia coli in 80% brushes and Klebsiella pneumoniae in 20% and the average colony-forming units (CFU) was 126555 CFU/mL, and the brushes usage time was on average 5 months.

Table 1 - Frequency of microorganisms found using the method of Cleri, Corrado and Seligman[5].

Bacteria	Percentage
Escherichia coli	45%
Klebsiella pneumoniae	35%
Streptococcus pyogenes	10%
Staphylococcus coagulase negative	10%

Table 2 - Frequency of CFU/mL in toothbrushes.

Class		Midpoint	Absolute frequency	Relative frequency
0	147000	73500	6	30%
147000	294000	220500	5	25%
294000	441000	367500	4	20%
441000	588000	514500	3	15%
588000	735000	661500	2	10%

Table 3 - Frequency of microorganisms found using the method Sherertz, Raad and Balani[22] (1990).

Bacteria	Percentage
Escherichia coli	80%
Klebsiella pneumoniae	20%

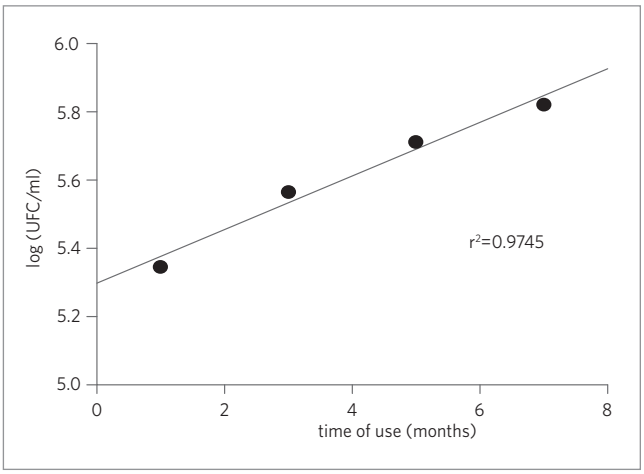


Figure 1 - Relation of bacterial growth medium (log(CFU/mL)) using the method of Cleri, Corrado and Seligman[5], and the time of use of toothbrushes (n=20).

DISCUSSION

The toothbrushes contamination can play an important role in the development of various diseases. Brushes should be replaced monthly and should not be stored in closed or wet containers, these locations associated with the substrate food scraps facilitate the microorganisms growth.[7,11] The second method by Cleri, Corrado and Seligman,[5] was suitable for studying microorganisms in toothbrushes. In this method, no dilution was performed to facilitate the growth and identification of contaminating microorganisms.

Taji and Rogers,[23] in their studies with toothbrushes, assessing contamination of utensils, identified the growth of Staphylococcus sp, Streptococcus,

Aerococcus sp, Pseudomonas sp, fecal coliform, among others. Toothbrushes can be a growth site for Streptococcus pyogenes and this microorganism is responsible for pharyngitis in children.[2] A study conducted by Moreira and Cavalcante[16] reported that 100% of contaminated brushes were positive for four species of microorganisms: Candida albicans, Escherichia coli, Streptococcus mutans and Bacillus subtilis. In our results 81% and 100% of the microorganisms identified in both methodologies were members of the family Enterobacteriaceae. Toothbrushes are usually stored in the toilets and exposed to contamination, since it is a microbial environment with the presence of mainly enteric bacteria spread by aerosols from the toilet.[23] A study of Long and Santos[14] indicated that none of the brushes that are kept inside the bathroom cabinet showed a growth of enterobacteria, whereas the degree of contamination with the presence of two major sorts of fecal coliforms (Enterobacter sp and Citrobacter sp) in brushes kept on the bathroom sink was 70%. The cabinet seems to be the safest place in the bathroom to prevent bristles contamination.

In previous studies we examined the toothbrushes time of use for each subject: 17.5% reported that they change their toothbrush every 30 days, 32.5% every six months and 50% of participants reported that only replace brush once a year. In this work, we found that the brush exchange is essential for good oral hygiene, since the longer is the use, the greater is the wear and microorganisms accumulation in the bristles. The presence of these organisms can be related to the lack of cleaning in the bristles or the brushes storage in wrong places with high rates of heat and humidity, which facilitates the spread and growth of these microorganisms. Among the survey members we found that 90% store the brushes in the bathrooms and among them 30% placed in lockers and 60% reported that the brushes are stored in a location such as exposed in the bathroom, over the sink, counter, glasses, among others. Regarding the use of protective cover on the brush, 90% of respondents did not use the cover protection on their brushes. The average number of persons using the bathroom was 3 per household, and 97.5% did not have habit of lowering the toilet lid to flush. Regarding the frequency of visits to the dentist, 7.5% reported visiting once a month, 15% every 6 months, 77.5% once a year and 97.5% reported that they never received instructions on how to properly store the toothbrush.

Grigoletto[12] and colleagues stated in their studies that the ideal use rate of toothbrushes is four per year, or one every three months. Study conducted in Brazil in 1997 showed that half of the population (about 85 million people) had no toothbrush and the per capita toothbrush consumption was considered low. Brazilians usually buy a brush every 17 months but the recommendation of the oral health society is to change the toothbrush every three months and every three days for patients undergoing chemotherapy.[2] According to Barros, Pernambuco and Tomita1 the brush should be kept clean without waste (food or toothpaste) and should be stored where it can dry and without direct contact with other brushes. According to the literature, there are some controversies regarding the storage of the brushes in the bathroom cabinets. Meier[15] and colleagues reported that the bathroom cabinet, boxes and bristles protectors are not the most appropriate location for the storage of toothbrushes, this is justified by the fact that those places maintain a moist environment and warm around the bristles and it may promote the microbial growth. Caudry and Klitorinos[3] and Coutinho[6] et al mentioned that the bathroom cabinet can favor the occurrence of cross-contamination, because the brushes are often stored with their heads in contact with other microorganisms that can pass to each other pathogens also related to respiratory infections, intestinal and other diseases. Brushes should be washed with running water and the water excess must be removed by tapping the edge on the sink and never dry in a towel, then you should spray on the bristles with mouthwash and store it in an open and airy place.[16] There are already some studies on the toothbrushes disinfection, Chaves[4] and colleagues (2007), reported that the decontamination process of brushes must have a longer range, including the poorest populations and should be evaluated by disinfection methods that are effective and easy to perform, such as the use of sodium hypochlorite 1% and 0.05% acetic acid. Good oral hygiene habits are common when oral health values are accepted as part of the family lifestyle,

and historically, women are more involved in this process. The mothers' example is crucial for their children to acquire good habits.[8]

CONCLUSION

According to the results presented in this study, we observed a high incidence of bacterial contamination in the analyzed brushes. The microorganisms more frequently found were members of the Enterobacteriaceae family. The toothbrushes time of use can be related to contamination found and therefore not only a good cleaning will ensure the reduction of microbial load, but the toothbrush exchange can also ensure better oral health to individuals.

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Evaluation of enamel surface after bracket debonding and polishing

Lilian Maria Brisque Pignatta[1], Sillas Duarte Júnior[2], Eduardo César Almada Santos[3]

Introduction: Preserving the dental enamel structure during removal of orthodontic accessories is a clinician's obligation. Hence the search for an evidence based debonding protocol.

Objective: to evaluate and compare, by means of scanning electron microscopy (SEM), the effects of four different protocols of bracket debonding and subsequent polishing on enamel surface, and to propose a protocol that minimizes damage to enamel surface.

Methods: Twelve bovine permanent incisors were divided into four groups according to the instrument used for debonding and removal of the adhesive remnant. In groups 1 and 2, brackets were debonded with a straight debonding plier (Ormco Corp., Glendora, California, USA), and in groups 3 and 4, debonding was performed with the instrument Lift-Off (3M Unitek, Monrovia, California, USA). In groups 1 and 3, the adhesive remnant was removed using a long adhesive removing plier (Ormco Corp., Glendora, California, USA) and in groups 2 and 4, residual adhesive was removed with a tungsten carbide bur (Beavers Dental) at high-speed. After each stage of debonding and polishing, enamel surfaces were replicated and electron micrographs were obtained with 50 and 200X magnification.

Results: All four protocols of debonding and polishing caused enamel irregularities.

Conclusion: Debonding brackets with straight debonding plier, removal of adhesive remnant with a tungsten carbide bur and polishing with pumice and rubber cup was found to be the protocol that caused less damage to enamel surface, therefore this protocol is suggested for debonding brackets.

Keywords: Dental enamel. Scanning electron microscopy. Orthodontics.

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How to cite this article: Pignatta LMB, Duarte Júnior S, Santos ECA. Evaluation of enamel surface after bracket debonding and polishing. Dental Press J Orthod. 2012 July-Aug;17(4):77-84.

Submitted: July 15, 2010 - **Revised and accepted**: September 19, 2011

» The authors report no commercial, proprietary or financial interest in the products or companies described in this article.

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INTRODUCTION

With the introduction of acid-etch bonding technology by Buonocore,[1] the direct bonding of brackets became the procedure of choice in orthodontic treatment.

Maximum preservation of enamel surface structure after orthodontic treatment with minimum enamel loss during bracket debonding and polishing is one of the goals of orthodontists.[2-5] However, the clinical sequence to debond brackets and to remove the adhesive remnant has been empirically proposed,[3,6] i.e., without a deep scientific investigation on how debonding techniques affect enamel surface.[7] Enamel damage can be attributed to tooth prophylaxis using abrasive materials,[8] enamel acid-etching technique,[5,8,9] enamel fractures caused by bracket debonding,[10] and removal of residual adhesive with rotary instruments.[5,8,11]

There are few reports in the literature that examined debonding techniques and their effects on the enamel surface.[4,12] It is widely known that debonding should not cause enamel irregularities.[6] such as furrows[2,3,13] and fractures.[14] Techniques that promote the union failure at the bracket-adhesive interface are most appropriated, because the adhesive remnant minimizes the risk of enamel loss during debonding.[4,12]

The search for an efficient and safe clinical protocol for removal of residual adhesive after debonding resulted in the introduction of a great variety of instruments and procedures.[8,15] This procedures including manual removal with curettes and adhesive removing pliers or band removing pliers,[2,5,6,8,13,16] tungsten carbide burs used at high or low speed,[2-7,9,11,13,15,17] polishing disks,[2,4,7,15,17] pumice or zirconia paste,[4,7,13,16,18] as well as the use of ultrasonic scalers.[9,16]

The presence of remnant resin facilitates plaque build-up, possibly leading to the formation of decalcified areas and caries lesions.[6] These remnants also can suffer discoloration, jeopardizing esthetics, a highly important factor in orthodontics.[6]

Inadequate procedures can cause enamel loss,[11,19] altering original tooth morphology with the formation of grooves and facets.[19] A consensual protocol of debonding and removal of adhesive remnant was not yet established, and there is a wide variety of clinical options, without real knowledge about the biologic cost to enamel.

There is a need to establish these procedures with criteria and biological bases, from bracket debonding to final polishing of enamel surface, and the scanning electron microscopy (SEM) allows greater precision in observing and examining enamel surfaces.

Thus being, the present study aimed to evaluate and to compare, by SEM, the effects of four protocols of bracket debonding, adhesive remnant removal and polishing, on enamel surfaces.

MATERIAL AND METHODS

For this in vitro study, twelve bovine permanent incisors, stored in 0.1% thymol solution,[4] were used.[20]

Verification of the existence of enamel cracks was performed by trans-ilumination of the buccal surface of teeth using fiber optic light[10] and 1.2X magnifying lens. Only teeth with no enamel cracks or caries were selected.

Teeth were sectioned at the crown/root anatomic limit using a cutting machine and distilled water irrigation.

The crowns` buccal surfaces were regularized under copious water cooling with silicon carbide discs (320 and 600-grit) (Buehler, Lake Bluff, IL, USA). Polishing was performed with felt disks and 6μ diamond aqueous suspension (Buehler, Lake Bluff, IL, USA).

Crowns were embedded in acrylic resin blocks and stored in 0.1% thymol solution until brackets were bonded.

All instruments used were brand new exclusive for this research.

Specimens were divided into four groups (n=3), according to the method used for brackets debonding and adhesive remnant removal (Table 1). The study outline, showing procedures, instruments used for brackets debonding, adhesive remnant removal and polishing, as well as the number of specimens in each group is represented in Figure 1.

Prophylaxis of enamel surface before bracket bonding was performed using a rubber cup (Microdont, Socorro, Brazil), ultra fine pumice powder (S.S. White, Rio de Janeiro, Brazil) and water at a low-speed. Enamel surface was rinsed with water spray for 10 seconds and dried with compressed air for the same time. The center of enamel surface was then etched with 35% phosphoric acid gel (Scotchbond Etchant, 3M ESPE, St. Paul, MN, USA) for 15 seconds, rinsed with water spray for 10 seconds and dried with oil-free compressed air jets for 10 seconds. A fine and uniform layer of Transbond™ XT Primer-Adhesive (3M Unitek, Monrovia, CA, USA) was applied to the prepared

Table 1 - Division of groups according to the instruments used for debonding and adhesive remnant removal and polishing, and the number of specimen for each group.

	Long adhesive removing plier/AEZ	Tungsten carbide bur
Straight debonding plier/AEZ	GROUP 1 (n=3)	GROUP 2 (n=3)
Lift-Off instrument	GROUP 3 (n=3)	GROUP 4 (n=3)

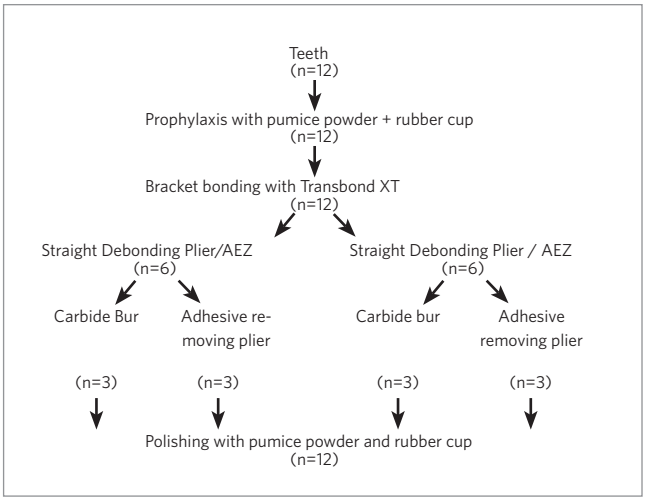


Figure 1 - Representative scheme of study outline showing procedures, instruments used bracket debonding, adhesive remnant removal and polishing, as well as the number of specimens in each group.

enamel surface with disposable microbrushes (Microbrush Corporation, Grafton, WI, USA) and spreaded with a short burst of moisture-free air blown.

Preadjusted stainless steel brackets for right maxillary central incisor (Kirium line, Abzil, São José do Rio Preto, Brazil) were positioned in the center of the crown long axis and bonded with Transbond™ XT (3M Unitek) composite resin, receiving a perpendicular force of 300 g, allowing excessive resin to flow off and producing a resin layer of similar thickness in all teeth.[21] Bracket/enamel interface was light-cured (Ultralux, Dabi Atlante, Ribeirão Preto, Brazil) at a distance of 5 mm for 10 seconds at the mesial surface and 10 seconds at the distal surface.

Bracket debonding was performed 24 hours after bonding.

In groups 1 and 2, brackets were removed using a straight debonding plier/AEZ (Ormco Corp., Glendora, CA, USA). The stainless steel blades of the plier were placed in the bracket/adhesive interface and a traction movement was performed.

In groups 3 and 4, brackets were debonded with the Lift-Off instrument (3M Unitek). The Lift-Off instrument has a metallic hook and a plastic pad. For debonding, the wire hook was placed in the right incisal tie-wing of the bracket and the plastic pad was placed on the crown's buccal surface, resulting in a traction force when activating the instrument.

After brackets debonding, in groups 1 and 3, the residual adhesive was removed with a long adhesive removing plier/AEZ (Ormco Corp.). The plastic interchangeable pad of the plier was placed on teeth`s incisal edge and the active tip was used to remove remnant adhesive by compression. In groups 2 and 4, residual adhesive was removed with a 12-blade tungsten carbide bur (#7642, Jet Carbide Burs, Beavers Dental, Ontario, Canada) at high-speed with copious water cooling.

Removal of remnant adhesive was verified by visual inspection under a dental operating light and using the round tip of an exploratory probe, simulating a clinical exam.

In all groups, final polishing was performed using pumice, water and a rubber cup at low-speed for 30 seconds. The surfaces were washed for 10 seconds and dried with an air syringe for 10 seconds.

After debonding, removal of adhesive remnant and polishing, enamel surfaces were replicated in epoxy resin for SEM evaluation.

Specimens preparation for SEM evaluation

Teeth crown were rinsed with water, dried with compressed air and fixed in glass plates with utility wax. Crown buccal surfaces impressions were taken by applying a medium viscosity fluid paste (Express™ STD - 3M ESPE, St. Paul, MN, USA), followed by a thick paste (Express™ STD - 3M ESPE, St. Paul, MN, USA). After the impression paste was set, teeth were removed and low-viscosity epoxic resin (Buehler, Lake Bluff, IL, USA) was poured into impressions to prepare the enamel surface replicas. The replicas were then placed on metallic bases and gold coated.

SEM evaluation of enamel surface

The scanning electron microscope (JSM T330A, JEOL, Tokyo, Japan) was used with an accelerating speed of 10 KV at a working distance of 10 mm. Each replica's image was magnified in 50X and 200X. Microscopic analysis was performed to evaluate enamel surface after debonding of brackets, removal of adhesive remnant and polishing, since these are the most critical stages regarding the occurrence of enamel damage. Images were stored in negative, digitized and then compared, considering similar magnifications.

Electron micrographs were evaluated by descriptive analysis. Images of groups 1, 2, 3 and 4 were selected to demonstrate typical appearance of enamel surface replicas in each stage.

RESULTS

Figure 2A shows the adhesive remnant on enamel surface after debonding with straight debonding plier in group 1 specimens. Removal of this residual adhesive with long adhesive removing plier caused enamel irregularities, vertical scratches and furrows (Fig 2B). Pumice polishing with rubber cup mitigated the scratches, remaining only the deepest furrows (Fig 2C).

In group 2, debonding was also made using the straight debonding plier, and some adhesive remained attached to enamel (Figure 3A). However, when adhesive removal was performed by tungsten carbide bur, enamel surface presented vertical and horizontal scratches (Fig 3B), which were mitigated after polishing with pumice and a rubber cup (Fig 3C).

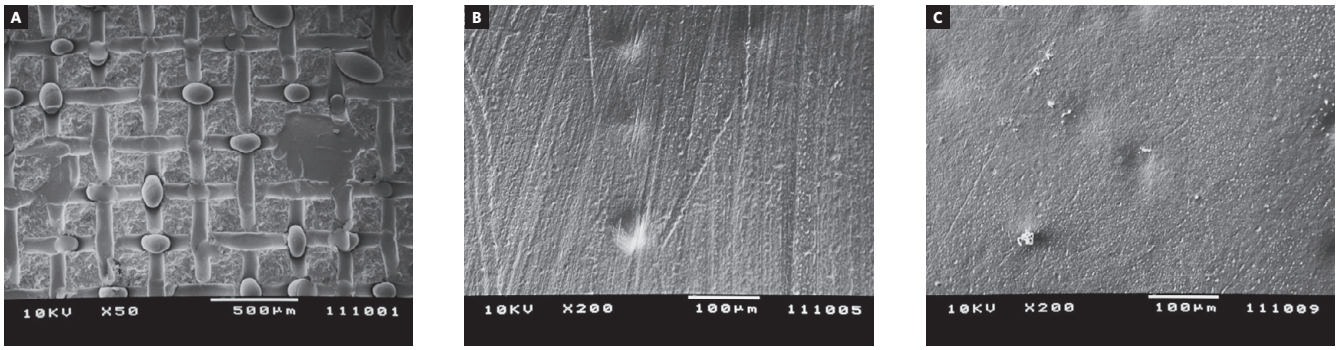


Figure 2 - Electron micrographs of group 1: **A**) debonding with straight debonding plier/AEZ (Ormco Corp.), **B**) removal of adhesive remnant with the long adhesive removing plier/AEZ (Ormco Corp.) and **C**) after pumice polishing with rubber cup.

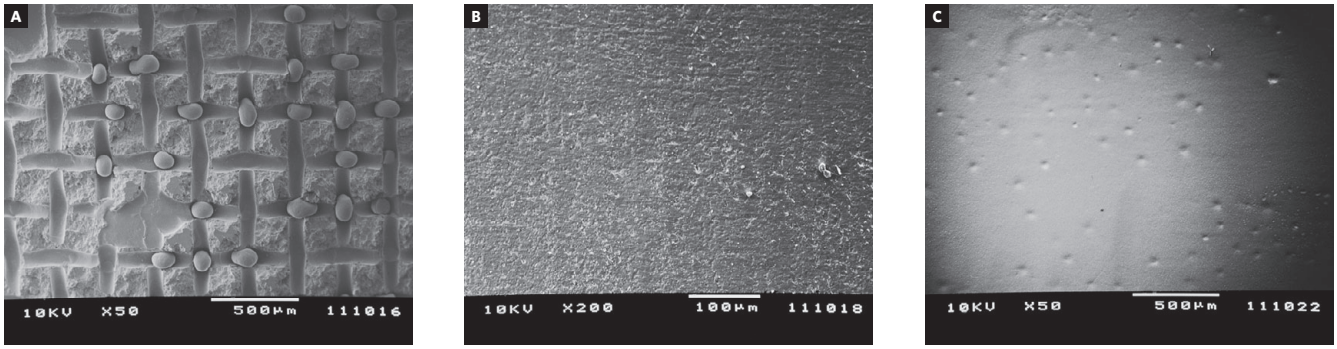


Figure 3 - Electron micrographs of group 2: **A**) debonding with straight debonding plier/AEZ (Ormco Corp.), **B**) removal of adhesive remnant with tungsten carbide bur (Beavers Dental) and **C**) after pumice polishing with rubber cup.

Figure 4A shows most part of adhesive remnant attached to enamel, after debonding with Lift-Off instrument, in group 3 specimens. Adhesive removal with long adhesive removing plier caused vertical scratches and furrows to enamel (Fig 4B). Pumice polishing with rubber cup mitigated the scratches, remaining only the deepest furrows, as presented on Figure C.

In group 4, in which debonding was performed with Lift-Off instrument, some adhesive also remained attached to enamel surface (Fig 5A). When this remnant adhesive was removed with a tungsten carbide bur, surface presented horizontal scratches (Fig 5B), which were mitigated after polishing with pumice and a rubber cup (Fig 5C).

DISCUSSION

Despite the frequent use of human premolars in adhesion tests in orthodontics,[22] the use of bovine teeth, especially permanent incisors, has become a viable alternative.

It is known that permanent and deciduous bovine enamel offers, respectively, 44% and 21% lesser resistance than human enamel.[20] This difference is attributed to the fact that bovine teeth has a faster formation and development, presents more irregularities and also larger and wider enamel crystals.[20]

On the other hand, this disadvantage is outweighed by several advantages of the use of bovine enamel, such as: the structure of bovine enamel is similar to human enamel; it can be more easily obtained; simpler approval

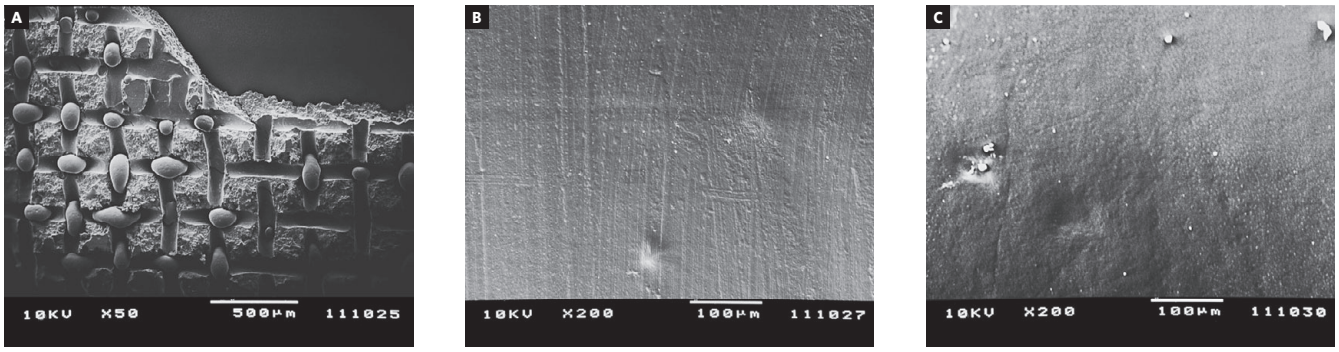


Figure 4 - Electron micrographs of group 3: **A**) debonding with the Lift-Off instrument (3M Unitek), **B**) removal of remnant adhesive with the long adhesive removing plier/AEZ (Ormco Corp.) and **C**) after pumice polishing with rubber cup.

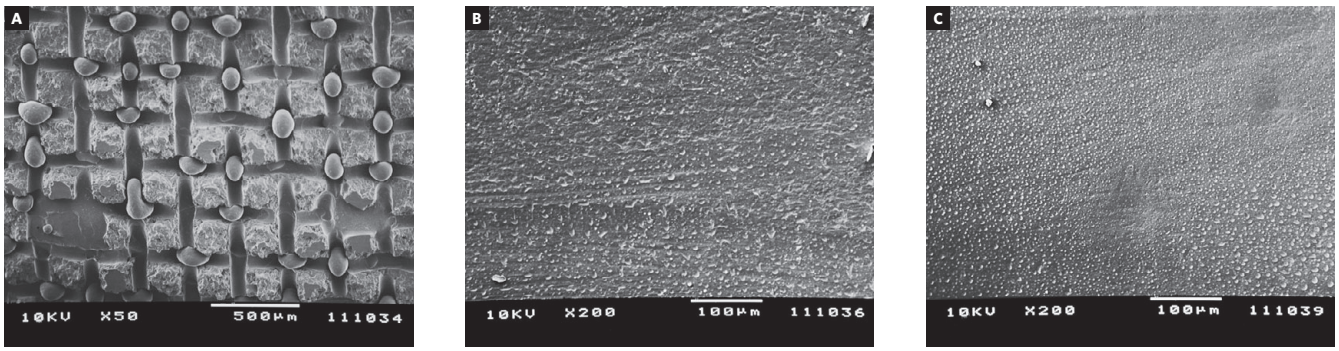


Figure 5 - Electron micrographs of group 4: **A**) debonding with the Lift-Off instrument (3M Unitek), **B**) removal of remnant adhesive with tungsten carbide bur (Beavers Dental) and **C**) after pumice polishing with rubber cup.

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in Researches Ethics Committee; it is possible to standardize the substratum, minimizing variables in the tested hypothesis ; and its storage time.[20]

Metallic brackets was chosen because debonding of ceramic brackets increases the risk of fractures of these attachments[23] and enamel scratches,[24] making difficult the preservation of enamel surface structure at the end of orthodontic treatment.

Bonding system Transbond XT (3M Unitek) was chosen due to its great physical properties and wide clinical use, demonstrating satisfactory longitudinal result,s and also due to its greater bond strength when compared to other bonding systems.[21,25]

Bracket debonding was performed 24 hours after bonding, when the resin bonding systems achieve their maximum strength, with no statistically significant difference after longer periods.[26]

SEM evaluation is essential for observation of enamel morphological changes after different procedures for bracket debonding and surface polishing.[2,3,4,7,13,15-18]

The use of epoxic resin replicas of the crown`s buccal surface allows the study of the each sequential step of bonding and debonding brackets, reproducing with great reliability the clinical situation.[7,13,27]

There is still no safe way of debonding brackets jointly with the adhesive without the risk of enamel damage, because bonding systems are developed to increase bond strengths between enamel, adhesive and bracket.[21]

To this date, the concept of ideal debonding consists of failure in the bracket/adhesive interface, with adhesive remaining on enamel surface to be cautiously removed with adequate instruments, resulting in less enamel loss.[4,12,28]

The use of straight debonding plier produced a force concentration on the bracket/adhesive interface, and failure in this interface prevailed, since all resin remained attached to enamel in four specimens (Fig 2A and 3A).

When brackets were debonded with the Lift-Off instrument, force was concentrated in the tie wing of brackets. In 3 specimens there was failure in the bracket/adhesive interface (Fig 5A), with adhesive remaining in tooth surface; however, in other 3 specimens, resin was partially removed along with the bracket at debonding (Fig 4A).

These results diverge from the findings of Årtun and Bergland,[28] Zarrinia, Eid and Kehoe[5] and Oliver,[12] which showed greater amount of resin attached to brackets when debonding was performed by applying force to the bracket base, instead the tie wings. This difference could be explained by the use of a different adhesive system. Knösel et al[29] do not recommend the instrument Lift-Off (3M Unitek) for debonding brackets because they cause more damage to the enamel.

Tungsten carbide bur has been the most recommended instrument for removal of adhesive remnant, both at low[5,7,9,11] and high speed.[2,3,4,13,15] However, when comparing the use of this bur at both speeds, Rouleau, Grayson and Cooley[13] and Eminkahyagil et al.15 verified best results at high-speed, while Ireland, Hossein & Sherriff,[9] found them at low-speed. The present work used the tungsten carbide bur at a high-speed with copious water cooling, because it is a fast procedure,[15] and the water cooling prevent pulp damage.[30]

Removal of adhesive remnant with both the long adhesive removing plier and the 12 blades tungsten carbide bur showed to be efficient. However, these instruments produced some irregularities on enamel surface, as observed in Figures 2B, 3B, 4B and 5B.

The long adhesive removing plier caused vertical scratches, as shown in Figures 2B and 4B. This could have happened because the instrument is applied to the incisal edge of the tooth crown and its active tip is used to remove the remnant adhesive by compression.

Similarly to the reports of Retief and Denys,[2] Gwinnett and Gorelick[6] and Rouleau, Grayson and Cooley[13] that manual instruments, like scoops and adhesive removing pliers, produce deep furrows that remain even after final polishing, the long adhesive removing plier can produce the same effects

The 12 blade tungsten carbide bur produced vertical scratches (Fig 3B), supposedly due to the disposition and number of blades of this instrument, and also horizontal scratches (Fig 3B and 5B), presumably caused during mesiodistal movement of the bur while removing the adhesive.

Retief and Denys,[2] Waes, Matter and Krejci,[11] Rouleau, Grayson and Cooley,[13] Eminkahyagil et al[15] and Ulosoy[31] also found scratches and furrows when using this bur, but reported that the adhesive remnant can be removed with minimal damage to enamel if the instrument was used carefully.

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Removal of all superficial adhesive remnant is essential, since its presence favors plaque accumulation, allowing the formation of decalcified areas and caries lesions.[6] The residual adhesive can also be discolored by action of bacteria, food, cosmetic and chemical alterations of the bonding material, jeopardizing esthetics, one of the most important factors in orthodontic treatment.[6]

Considering that the procedures of debonding, adhesive remnant removal and final polishing can also remove some enamel tissue.[11,19] they can cause changes in tooth morphology with formation of hollows and facets.[19]

Literature reports enamel loss varying from 27.5 to 48 µm.[19] from 26.1 to 41.2 µm[8] and 55.6 µm[32], depending on the bonding system's filler characteristics, the instruments used, as well as on the measurement technique. This enamel loss is not clinically significant when compared to the average enamel thickness, which varies from 1500 to 2000 µm.[19]

Enamel loss during debonding procedures became clinically significant considering that the highest concentration of fluorides is located on the surface, and it declines significantly in the first 20 µm of enamel.[19] This way, the use of instruments and preservative techniques assumes great importance, because of the possibility of multiple bonding and treatments which could trespass this thickness.

Final polishing is considered an indispensable step to minimize enamel damage produced during debonding and adhesive remnant removal,[2,3,4,6,7,16,18,19] as observed in Figures 2C and 5C. The use of pumice, water and a rubber cup is the most suitable procedure because it removes less enamel when compared to bristle brushes.[8,19]

In the present work, it was observed that final polishing with pumice, water and a rubber cup minimized scratches and furrows, remaining only the deepest ones (Fig 2C, 3C, 4C and 5C), corroborating the results of Burapavong et al,[16] Rouleau, Grayson and Cooley[13] and Vieira et al,[18] therefore, this procedure is indicated after using any adhesive removing instrument.

Enamel appearance after debonding and polishing should be compared to the adjacent surfaces. The clinical exam of enamel both dried and moistened is important because of reflection and refraction phenomena related to the moistened surface that can mask some irregularities.[6]

Among all aspects evaluated in the present study, it is advisable to use an ideal sequence of clinical steps when debonding brackets, aiming at less damage to enamel surface and at clinical feasibility under actual conditions.

CONCLUSION

All four protocols for bracket debonding, removal of adhesive remnant and polishing caused enamel irregularities.

Brackets debonding using the straight debonding plier, followed by removal of residual adhesive with tungsten carbide bur at high-speed and water cooling, and polishing with pumice and a rubber cup showed to be the protocol that caused the least damage to enamel, and therefore, it is the suggested debonding protocol.

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Bracket/wire play: What to expect from tipping prescription on pre-adjusted appliances

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Introduction: The opinion on the 'straight-wire' concept has been evolving since its origin, characterized by faithful followers or absolute skepticism. Currently, it seems reasonable to state that most professionals have a more realistic and critical viewpoint, with an attitude that reveals Orthodontics' maturity and greater knowledge on the technique. The most relevant criticisms refer to the impossibility of the both the Straight-Wire and the Standard systems to completely express the characteristics related to the brackets due to mechanical deficiencies, such as bracket/wire play.

Objectives: A critical analysis of this relationship, which is unclear due to lack of studies, was the scope of this paper.

Methods: The compensatory treatment of two patients, using Capelozza's individualized brackets, works as the scenery for cephalometric evaluation of changes in incisor inclination produced by different dimensions of leveling archwires.

Results: The evaluation of these cases showed that, while the introduction of a 0.019 x 0.025-in stainless steel archwire in a 0.022 x 0.030-in slot did not produce significant changes in incisor inclination, the 0.021 x 0.025-in archwire was capable of changing it, mainly in mandibular incisors, and in the opposite direction to the compensation.

Conclusion: Considering compensatory treatments, even when using an individualized prescription according to the malocclusion, the bracket/wire play seems to be a positive factor for malocclusion correction, without undesirable movements. Therefore, it seems reasonable to admit that, until a bracket system can have absolute individualization, the use of rectangular wires that still have a certain play with the bracket slot is advisable.

Keywords: Orthodontic brackets. Orthodontics. Rectangular wires.

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How to cite this article: Capelozza Filho L, Machado FMC, Ozawa TO, Cavassan AO, Cardoso MA. Bracket/wire play: What to expect from tipping prescription on pre-adjusted appliances. Dental Press J Orthod. 2012 July-Aug;17(4):85-95.

Submitted: April 1, 2010 - **Revised and accepted**: February 15, 2012

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

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INTRODUCTION

The rationale of straight wire mechanics is to adequately position teeth without the need of bending orthodontic archwires, transferring to the brackets the ideal positioning characteristics for each tooth at treatment completion. These characteristics, including angulation, inclination, inset and offset, present in each bracket, determine the so-called prescription.

Andrews's[2] original proposal[2] acknowledged differences in the movements that should be performed to the teeth to meet the therapeutic goals, which in turn were also distinct according to the malocclusion. Within this context, the author offered multiple brackets with different angulation and inclination prescriptions, which when combined allowed an extensive and varied range of combinations that might be called individualized. In practice, it seems that the wide use of these resources was not adopted. The probable cause for this was the premise that it might be possible to treat all patients with a single set of brackets, which would be much more convenient and simple.

Since the introduction of the straight wire appliance, several alterations were suggested for inclination and angulation values in the different prescriptions, in the attempt of treating the greatest number of cases without the need to include bends in leveling archwires. The great number of prescriptions currently available in the market, with such different values, reveals that this subject is far from reaching unanimity. The impossible search for a prescription that may be adequate to all cases still exists, though widely criticized in the literature, since it opposes the extensive morphological diversity of mankind, including face and obviously teeth.

Primary and usually unclear differences underlying these prescriptions should be considered. Some authors` intention is to alter the values of prescriptions individualizing the brackets according to the type of movement to be performed (individualization for movement) or according to the tooth positioning foreseen at treatment completion (individualization for finishing). Both might be useful when justified by the therapeutic goals.

These variations in prescriptions most of the times include variations in inclination and angulation. Others, such as in and out differences to control rotation during movement, seems to have been originated and restricted to Andrews[2] appliance. An exception to this rule is the absence of molar off-set adopted for maxillary molars finalized in Class II molar relationship, specific and non-controversial.

One of the criticisms associated to the straight wire technique refers to the prescription expression capacity, since in most cases treatment is not conducted up to the thickest archwires, and even in that case, inherent deficiencies of the edgewise system such as play and force reduction would preclude the complete prescription expression. The expression of inclination seems to be more critical, being object of greatest controversies and will be addressed in this paper.

Conversely, when the subject is variation in prescriptions, tooth positioning at treatment completion seems to be an essential consideration. The last decade has enlightened the orthodontic community with a clear perception on the limitations of growth manipulation, evidencing the compensatory characteristics present at completion of the so-called "orthopedic-in treatments in patients with skeletal malocclusions. Within this context, the treatment goals for these patients should be revised. The acceptance of differential values for the buccolingual inclination of incisors as a characteristic of compensation of the remaining maxillo-mandibular discrepancy, implies an alteration of the desirable or possible inclination for these teeth at treatment completion, reinforcing the concept of individualization according to the type of malocclusion to be treated. In these cases, besides alignment and leveling, the brackets also assist on the establishment of compensation characteristics, when these are not yet present, or on their maintenance when they are already present as a result of previous orthopedic approaches or even natural compensation.

The concept of play

An important mechanical deficiency that has been more discussed in the literature after introduction of the straight wire technique is the play between the leveling archwire and the bracket slot. This makes sense, considering that in the edgewise technique the archwire was torqued as necessary, while theoretically it would not be manipulated in the straight wire technique. This play, also called deviation angle, was defined as a rotation movement of the rectangular archwire from its passive position (transverse section of

archwire parallel to the slot walls) to a position where two opposite edges of the archwire contact two opposite walls of the bracket slot[16] (Fig 1).

Initially, calculations using mathematical equations, considering brackets and archwires` nominal values, provided the first play values between archwire and bracket slot.[11] However, when examining the actual dimensions of brackets and archwires, it was observed that the nominal values did not correspond exactly to their dimensions. There is some variation around the nominal value, called tolerance limit of manufacturers. This would occur because the manufacturers fabricate archwires which dimensions are never greater than nominal values, and bracket slots slightly greater than nominal values. This would avoid problems at insertion and removal of archwires, especially the larger ones, besides providing adequate depth to allow correct positioning in the slot.[19] However, the tolerance values of manufacturers tend to increase the play values.[10,11]

When the method employed to analyze the play first involved a torque meter and not a mathematical equation, even higher play values were found.[14] The explanation for such different values was that the archwires, when microscopically analyzed, exhibited beveled edges that would reduce its torque capacity, increasing the play. This occurs due to the manufacturing process of rectangular archwires, which are obtained by grinding a round archwire of greater diameter.[19] Therefore, the edge remains rounded, evidencing that the Edgewise technique is not quite a sharp edge technique . This rounding of the edge could contribute for varied play values depending on the archwire composition.[19] Combined to these factors, the concept of force reduction would also act reducing the capacity of torque expression.[9] Table 1 presents the play values found in the literature and the different methods employed for measurement.

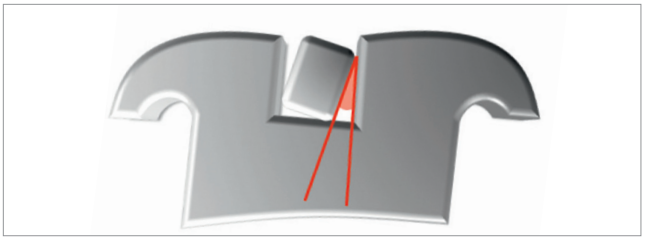


Figure 1 - The play (deviation angle) can be defined as an angular rotation of the wire, from its passive position (cross-section of the wire parallel to the slot walls) until the position where the diagonal corners of the wire contact the opposite wall of the slot.

Recognizing these limitations and considering that they would be more significant in teeth submitted to extensive movements, Andrews[2] designed brackets with compensatory characteristics of mesiodistal contra-angulation, buccolingual contra-inclination and anti-rotation for cases involving tooth translation, so that at treatment completion teeth would have in correct positioning.

Other authors, considering the same mechanical deficiencies, suggested changing the prescription values to enhance the torque control, especially during anterior retraction mechanics. Concerning the inclination of maxillary incisors, Roth;[18] Mclaughlin, Bennett, Trevisi[15] and Ricketts[17] suggested different increases in the inclination values to obtain better torque control in anterior retraction movements. For mandibular incisors, Mclaughlin, Bennett, Trevisi[15] and Alexander[1] suggested a reduction in Andrews[2] original value. The explanation for this individualization would be controlling an effect considered undesirable by the authors: The buccal inclination of mandibular incisors during leveling. As far as it is known, this explanation lacks rationale, considering that, initial leveling archwires are round or have reduced dimensions, not exerting any control on the buccal inclination of incisors. This reduced inclination would further act as a resistant negative torque during the use of Class II elastics, which may or not be useful depending on the therapeutic intention. Regarding compensatory treatments, this inclination lacks logic, especially after growth completion.

Table 1 - Compilation of play values reported in the literature.

Author	Method	0.019 x 0.025-in archwire x 0.022-in slot	0.021 x 0.025-in archwire x 0.022-in slot
Dellinger[11]	Mathematical calculation based on nominal values	7.88°	2.93°
Dellinger[11]	Mathematical calculation based on maximum tolerance values	9.63°	4.32°
Creekmore[10]	Data provided by Unitek, considering the tolerance values	10.5°	3.9°
Hixson et al[14]	Torque meter	12.8°	8.4°
Sebanc et al[19]	Torque meter	10.9–23.9°	4.5–8.3°

In summary, it should be recognized that all these individualizations are designed for movement. The difference between these authors is that Mclaughlin, Bennett and Trevisi[15] ruled out the need to manage the angulation for individualizing the movement, adopting only the management of inclination. However, all authors have made a mistake against the essence of the straight wire concept, when determining that these brackets could or should be used generically.

Biological variation

In addition to the mechanical deficiencies of the edgewise technique, another great criticism to the straight wire appliance was the mistaken concept that extrapolates its author's[2] concept ,that a single prescription could be suitable to all patients, ignoring, for example, the wide biological variation demonstrated in buccal surface contours of teeth.[11,21,22] In all studies, the standard deviation was significant and increasing in anteroposterior direction,[11,21,22] precluding the use of mean values as a rule, since identical bracket bases would adjust differently on each tooth surface. Therefore, the authors conclude that the use of reduced diameter archwires, allowing a certain play between archwire and bracket slot, is the mechanical property that allows the use of straight wire appliances in a large number of cases without causing undesirable effects.

Andrews,[2] in his original paper, also comments on the wide variation existing in the inclinations of buccal surfaces of clinical crowns, yet in his studies the greatest variation was concentrated on the incisors region and was not related to variations in the buccal surface contour, of clinical crowns but rather to changes in the dental inclinations of incisors, as a compensating mechanism in cases of small to moderate discrepancy between the bone bases. For these cases, Andrews[2] designed a variation of regular brackets with differential values for the inclination of incisors. This is one among several evidences that the author recognized the impossibility to apply with excellence a single set of brackets to all patients.

Bibby,[3] Casko and Shepperd[8] reported variations in the inclination of incisors in different skeletal patterns, clearly demonstrating the incisor compensation capacity in cases of small to moderate sagittal discrepancy, with the clear goal to maintain an adequate overjet. Solow[20] discusses that using cephalometric norms for positioning incisors to achieve ideal outcomes in cases of skeletal discrepancy is a great mistake. According to Handelman[12] and Capelozza,[5,7] the most adequate positioning parameter would be never surpassing the biological limits during treatment, determined by the positioning of buccal and lingual cortical plates. Clinical monitoring, with evaluation of periodontal quality and primarily considering the attached gingiva, might define the limits and type of movement.[5,7]

Individualization

In 1999, Capelozza Filho[5] reintroduced the concept of individualization for finishing. His prescription is based on the same individualization concept for finishing originally proposed by Andrews,[2] i.e. altering the inclination values of incisors to compensate an altered bone base relationship. It is known, from clinical and research standpoints,[4] that cases finalized with excellence may present extreme variations in inclination, especially for mandibular incisors. Also, the author[5] suggests individualizing the angulation, a new and very important concept to generate or consume space, avoiding or potentiating tooth movements according to the therapeutic intentions. The angulations of maxillary and mandibular canines and incisors are altered to allow these teeth to occupy more or less space according to the specific need. As a consequence of the decision of angulating a tooth, there will be spontaneous repercussions in the movement of this tooth and adjacent teeth and other non-spontaneous repercussions that should be recognized and managed by the orthodontist.[5,6,7] More recently, a new bracket for maxillary canines (zero angulation) was introduced for maximum compensation (minimum protrusion) in the compensatory treatment of Pattern II malocclusions (Tabs 2 and 3).

The author considers that angulation is a more important individualization aspect than inclination because of its earlier manifestation, since the first archwire; more constant and progressive, for it can be expressed by all archwires; and probably more expressed by the rectangular archwire.[5,7] However, in this paper, the inclination will be specifically analyzed in accordance with the proposal and methodology adopted.

The effects of prescription for inclination, together with the concept of play and biological variation, will be discussed by presentation of case reports in which

Table 2 - Capelozza Filho[5] prescription for maxillary incisor and canine brackets for treatment of Pattern I, II and III malocclusions.

MAXILLARY ARCH										
	PATTERN II				PATTERN I			PATTERN III		
	Central incisor	Lateral incisor	Canine	Canine II Plus	Central incisor	Lateral incisor	Canine	Central incisor	Lateral incisor	Canine
Angulation	5°	9°	5°	0	5°	9°	8°	5°	9°	11°
Inclination	+7°	+3°	-5°	-8	+7°	+3°	-5°	+14°	+10°	-2°
Projection	1,5 mm	1,9 mm	1,4 mm	1,4 mm	1,5 mm	1,9 mm	1,4 mm	1,5 mm	1,9 mm	1,4 mm

Table 3 - Capelozza Filho[5] prescription for mandibular incisor and canine brackets for treatment of Pattern I, II and III malocclusions.

MANDIBULAR ARCH							
	PATTERN II			PATTERN I		PATTERN III	
	Incisors	Incisors Plus	Canine	Incisors	Canine	Incisors	Canine
Angulation	2°	2°	5°	2°	5°	0°	0°
Inclination	+4°	+8	-11°	-1°	-11°	-6°	-11°
Projection	1,9 mm	1,9 mm	1,4 mm	1,9 mm	1,4 mm	1,9 mm	1,4 mm

brackets with slot 0.022 x 0.030-in manufactured by ABZIL were used, with individualized prescription according to the facial pattern. An alignment and leveling protocol was established up to utilization of 0.021 x 0.025-in rectangular archwires. Cephalometric radiographs were obtained in defined intervals as follows: T_0 – initial; T_1 – at completion of 0.020-in leveling; T_2 – 45 days after placement of 0.019 x 0.025-in leveling archwire; and T_3 – 45 days after placement of 0.021 x 0.025-in leveling archwire. During this evaluation period, which comprised the 0.020-in up to 0.021 x 0.025-in archwires, no other mechanical resource was used in combination to the leveling archwires to avoid interference. The rectangular archwires remained installed for a minimum period of 45 days, when patients were radiographed. All archwires were checked before placement and did not present any torsion that might alter the prescription of brackets.

The measurements selected to evaluate the evolution of incisors during treatment were IMPA and 1.PP. All radiographs were obtained using a single equipment, traced by a single examiner and checked by a different examiner. The tracing was then digitized and measurements were performed on a computer.

Case report 1

Female patient, aged 13 years, pattern III, presented a straight profile with mild maxillary deficiency and slight mandibular deviation to the right side. When evaluated in centric relationship, the patient presented an edge-to-edge anterior relationship. The maxillary arch exhibited crowding in the right posterior region, with lingual rotation of the maxillary right second premolar (Fig 2). The incisor inclination already demonstrated some degree of dental compensation before treatment, with 1.PP measuring 121.7° and IMPA 86.8°.

The proposed treatment planning included maxillary rapid expansion, followed by maxillary protraction with compensatory intention since the patient was in the final growth period, with the history of menarche six months before treatment onset. Attached to the modified Haas expander, was a TMA coil of Pendex[13] type for distalization of the maxillary right second molar and consequent achievement of space for the maxillary right second premolar. During maxillary protraction the mandibular leveling was initiated, using Capelozza Filho's Class III prescription , with torque of -6° for mandibular incisors since it was predicted that compensation, already present before treatment, would be increased by the applied mechanics and,at treatment completion, the mandibular incisors would present remarkably reduced inclinations. Concomitant to maxillary protraction, Class III elastics were used as part of the protocol, initially attached to the mandibular canines and later to the archwire. This was installed since the early stages of mandibular leveling to avoid any buccal tipping of mandibular incisors during leveling.[6,7]

In this particular case, regular prescription was used in the maxillary arch since the clinical evaluation of inclination of the buccal surfaces of the maxillary incisor crowns,

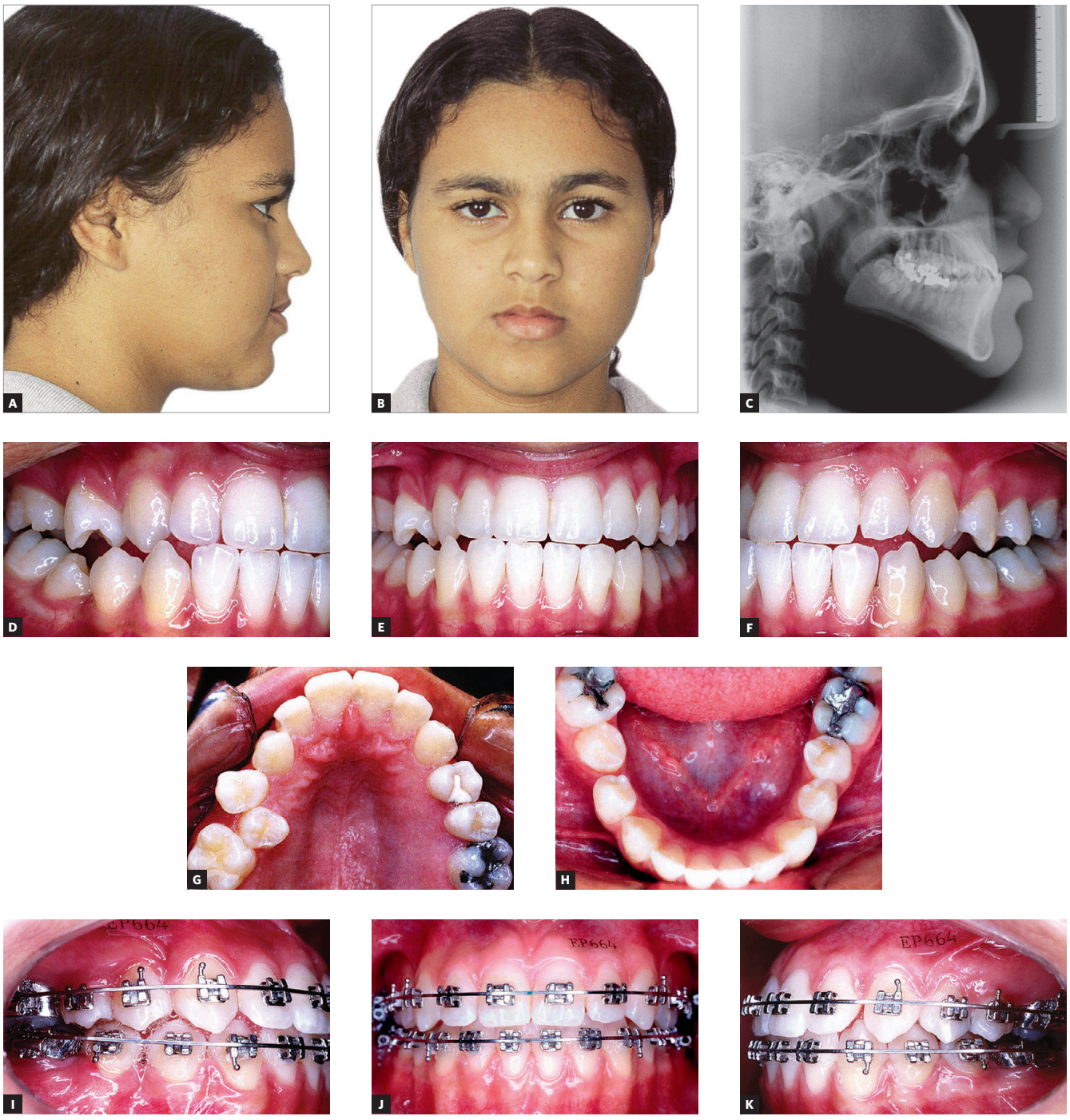


Figure 2 - Case 1: Initial records (**A-H**) and at placement of 0.021"x 0.025-in levelling archwire (**I, J, K**).

even after using the mask, did not reveal great buccal inclination to justify the use of Prescription III. This greater potential of compensation may jeopardize the facial esthetics by elevating the anterior occlusal plane and closing the nasolabial angle,hence it should be avoided in Caucasoid patients when possible.[6,7]

The maxillary and mandibular leveling was continued up to 0.021 x 0.025-in archwire. The evolution of incisors during the different stages of leveling is presented in Figure 3. Comparison of the initial radiograph (T_0) with the one obtained at completion of 0.020-in leveling (T_1) clearly demonstrates the influence of elastics mechanics associated to maxillary protraction on the mandibular incisors, promoting an IMPA reduction of 3.6º, from 86.8º to 83.2º. The inclination of maxillary incisors was nearly unaltered during this stage. The introduction of 0.019 x 0.025-in archwire promoted buccal inclination in maxillary

incisors and nearly did not alter the inclination of mandibular incisors. With the introduction of 0.021 x 0.025-in leveling archwire, there was a reduction of 1.2º in the inclination of maxillary incisors and increase of 1.1º in the inclination of mandibular incisors. Considering the concept of play between the slot and the bracket, it is easy to explain the evolution of mandibular incisors, which presented a more negative inclination than the -6º prescription contained in the bracket at completion of 0.020-in leveling. Introduction of the 0.019 x 0.025-in archwire did not have a significant effect in inclination, possibly due to the great play between this archwire and the slot. With introduction of the 0.021 x 0.025-in archwire, reduction of the play promoted an active positive torque, which was responsible for the IMPA change. The Class III prescription in this case was effective to avoid undesirable effects with the 0.019 x 0.025-in archwire, yet still insufficient to avoid the undesirable buccal inclination for Class III correction when using the 0.021 x 0.025-in archwire. However, the amount of torque promoted by the 0.021 x 0.025-in archwire did not lead to the loss of overjet correction . It is more difficult to explain the evolution of the maxillary incisor, which exhibited buccal tipping with utilization of the 0.019 x 0.025-in archwire and then palatal inclination when using the 0.021 x 0.025-in archwire. The most probable explanation is that the buccal inclination of maxillary incisors occurred during 0.019 x 0.025-in leveling is that it might have been a side effect of torque correction on the posterior teeth. After maxillary rapid expansion; the posterior teeth were strongly buccally inclined, hence the reduction of transverse dimensions of the maxillary arch by palatal inclination of posterior teeth may have led to an increase in arch length (buccal inclination of incisors) to maintain a constant perimeter (sum of mesiodistal size of aligned maxillary teeth without crowding). The play existing when using the 0.019 x 0.025-in archwire allowed buccal inclination of the maxillary incisor up to the play extent. With introduction of the 0.021 x 0.025-in archwire, the play reduction promoted an active negative torque, reducing the 1.PP (Fig 3).

An important consideration in this case is that, if a regular prescription was used in the mandibular arch, introducing angulations for the anterior teeth, such a significant reduction in IMPA would hardly be achieved up to 0.020-in leveling. The torque would also be concerning, considering the mandibular incisors crowns presented a torque lower than -6º, which was confirmed after introduction of the 0.021 x 0.025-in archwire. The use of regular prescription for inclination (-1º) might cause an active positive torque of the crown when introducting the 0.019 x 0.025-in archwire, and the use of a 0.021 x 0.025-in archwire with regular prescription might have led to loss of anterior relationship. The use of other mechanical resources to avoid this,could have unfavorable effects on the roots and supporting bone relationship.

Case report 2

Female patient, aged 12 years, Pattern II, presenting mandibular deficiency evidenced by a short chin-neck line and marked mentolabial sulcus. The intraoral examination evidenced maxillary atresia, which however

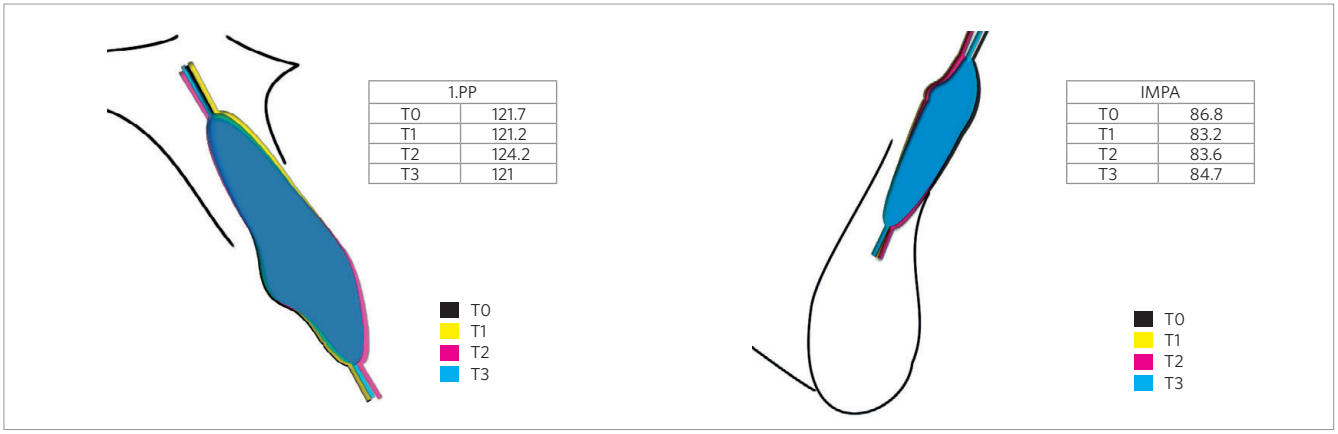


Figure 3 - Cephalometric superimposition of IMPA and 1.PP evolution from initial leveling up to 0.021 x 0.025-in archwire. T_0 - Initial, T_1 – After leveling with 0.020-in archwire, T_2 - After leveling with 0.019 x 0.025-in archwire, T_3 - After leveling with 0.021 x 0.025-in archwire.

did not lead to posterior crossbite because it was combined with atresia of the mandibular dental arch. This atresia of both arches caused tooth crowding in both maxillary and mandibular arches. The Class II interarch relationship was coincident with the facial pattern. Analysis of the initial cephalogram (T_0) demonstrated maxillary and mandibular incisors well-positioned in their bone bases;with 111.2° for 1.PP and 93.5° for IMPA.

The proposed treatment plan included initially the reestablishment of dental arch morphology by means of a maxillary rapid expansion and slow mandibular arch expansion using an expanded lip bumper. After transverse correction, compensatory correction of malocclusion in the sagittal plane was initiated. This correction used an extra-oral anchorage for distalization of the maxillary first molars and prescription II,



Figure 4 - Case 2: Initial records (**A-G**) and at placement of 0.021 x 0.025-in levelling archwire (**H, I, J**).

since the prediction for finishing indicated that the mandibular incisors would maintain or even increase their degree of buccal inclination. The crowding would be relieved by transverse expansion in both arches and sagittal expansion by distalization of maxillary molars and protrusion of mandibular incisors.

The radiographic evaluation after 0.020-in leveling (T_1) revealed an increase of 4° (from 93.5° to 97.5°) in the inclination of mandibular incisors, a reflex of the expansion mechanics applied. The slight increase in the maxillary incisors inclination (1.PP went from 111.2° to 111.9°) suggests that the expansion mechanics in the maxillary arch caused more transverse expansion and distalization of maxillary molars.

The effects of leveling with 0.019 x 0.025-in archwire, demonstrated by comparison of cephalograms at T_2 and T_1, indicated an increase of 1.1° (from 111.9° to 113.0°) in the inclination of maxillary incisors. The mandibular arch nearly did not present changes by introduction of the 0.019 x 0.025-in archwire. The leveling protocol was continued by introduction of 0.021 x 0.025-in leveling archwire. Comparison of 1.PP and IMPA values from the cephalograms at T_3 and T_2 allows to infer the actual effect of the leveling with 0.021 x 0.025-in rectangular archwires. These effects, in this patient, were reduction of buccal inclination of both maxillary and mandibular incisors.

The explanation for the evolution of the maxillary incisors inclination in this case (Fig 4), that first were buccally inclined in 1.1° by introduction of the 0.019 x 0.025-in archwire, then lingually tipped in 0.7° with the increase in the dimension of the rectangular archwire (0.021 x 0.025"), may be explained, similarly to case 1: As an interference of posterior teeth torque correction on the incisor inclination after the patient was submitted to maxillary rapid expansion.

In the mandibular arch, introduction of the 0.021 x 0.025-in archwire promoted great negative torque and the outcome was an IMPA reduction of 3.4° (from 97.3° to 93.9°). The force binary acting on the crown and the impossibility to promote lingual movement of the crown due to lack of space, caused buccal movement of the root, pushing it against the buccal cortical plate. This highly undesirable movement due to its iatrogenic potential,[12] fortunately, did not cause negative consequences in this case. It should be noted that even a prescription aiming to allow greater buccal inclination of the mandibular incisor was not sufficient for the degree of compensation exhibited by these teeth. The result might have been even greater if a regular prescription (-1°) was used. Prescriptions with individualization for movement, such as MBT(-6°),[15] might cause even worse consequences. Considering that, the torque values published by Creekmore,[10] revealed a difference in play between 0.019 x 0.025-in and 0.021 x 0.025-in archwires of 6.6° and that in this case the clinically more significant torque was produced by the 0.021 x 0.025-in archwire, the difference of 5° between the regular prescription (-1°) and the Class II prescription (+4°) might promote active torques with clinical significance early in the 0.019 x 0.025-in archwire. If brackets with -6° torque were used, the negative torque effects would certainly manifest early in the 0.019 x 0.025-in archwire. This would surely be highly undesirable, since unlike the 0.021 x 0.025-in archwire, the 0.019 x 0.025-in

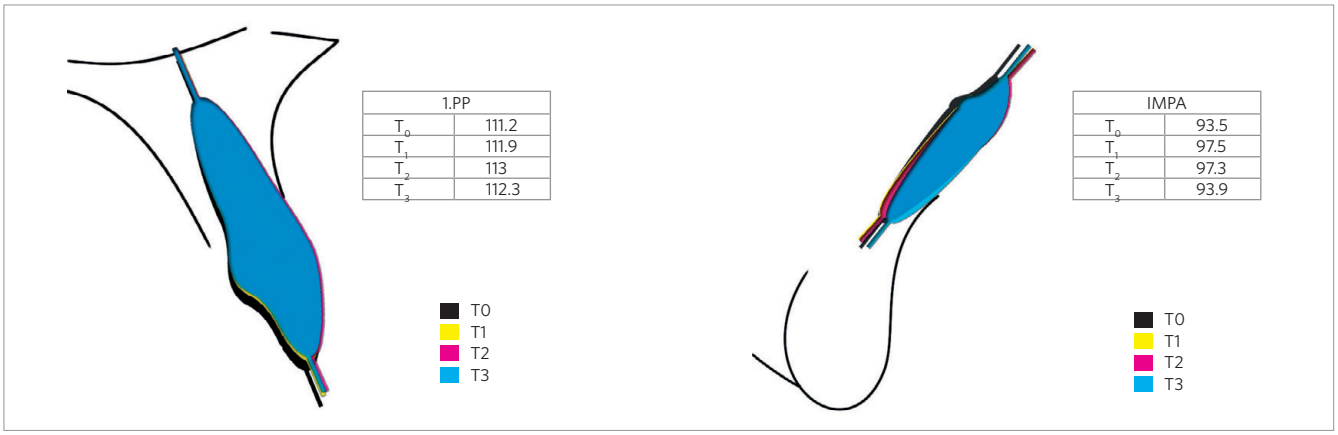


Figure 5 - Cephalometric superimposition of IMPA and 1.PP evolution from initial leveling up to 0.021 x 0.025-in archwire. T_0 - Initial, T_1 – After leveling with 0.020-in archwire, T_2 - After leveling with 0.019 x 0.025-in archwire, T_3 - After leveling with 0.021 x 0.025"archwire.

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archwire is routinely employed and usually remains engaged to the brackets for longer period than adopted in the present study. Moreover, intermaxillary elastics are usually employed with this archwire. The use of Class II elastics in an archwire with active negative torque would further increase the buccal movement of the root, since the force applied by the elastics would act on the crown pushing it in the buccal direction, and the active negative torque would promote a force binary to lingually incline the crown. The resulting force would then produce buccal movement of the root pushing it against the buccal cortical plate, and the extension of root movement would be related to the quantity of force generated by the intermaxillary elastics. This is at least unintelligent.

The classical torque proposal, when Class II intermaxillary elastics are used, is that there should be resistant negative torque in mandibular incisors as an attempt to minimize the buccal inclination of incisors and use the buccal surfaces of the mandibular incisors roots as part of the anchorage unit, when elastics are being used to assist the maxillary anterior retraction, for example. Some prescriptions, as the MBT,[15] intent to include this torque in the mandibular incisors brackets altering the value to -6º. However, the concept of resistant torque is relative, and the torque present in the bracket is only one of the factors that will determine the type of torque produced;it should also be considered the crown`s initial buccal inclination and the amount of play between archwire and slot. In the present case, the 0.019 x 0.025-in archwire effect of not altering significantly the IMPA demonstrates a resistant negative torque, since the crown presented greater torque than the one existing in the bracket, which was only confirmed after the introduction of the 0.021 x 0.025-in archwire caused IMPA reduction. This evidences that, to determine which degree of torque a tooth will receive with a certain prescription, it is also necessary to evaluate the inclination present in the buccal surface of the tooth crown.

Some concepts, widely used regarding torque in the conventional Edgewise philosophy, should be revisited and better understood to be adapted to the Sraight-Wire philosophy.

In the conventional Edgewise philosophy, actual torque was that applied to the archwire and checked with pliers, and could be considered as neutral, buccal or lingual, according to the region where the archwire passed when held by the plier. This same archwire, when inserted in a bracket, delivered the so-called relative torque, which was the most important one, since the interaction between the torque in the archwire and the crown inclination determined the actual effect that would be achieved. Therefore, the relative torque could be considered passive, resistant or active.

In the straight wire philosophy these concepts had to be revised, because of the proposal to include in the bracket the positioning characteristics that were previously applied to the archwire. Thus, in the straight wire, the actual torque is present in the bracket, yet the most important factor is still the relative torque, which is measured in relation to the crown inclination. Similarly to the conventional Edgewise philosophy, the clinical observation of the archwire position when inserted into the bracket may be used to check the relative torque. However, with better understanding on the concepts of play and force reduction, a new manner of explaining passive, resistant and active torques may be employed. Whenever a rectangular archwire is inserted into a bracket whose crown inclination is contained in the play interval of the archwire, this torque may be considered passive since it will not promote any inclination movement. When the crown inclination is greater than the play limit, yet within a small range above and below the play interval, in which the resulting force binary is not intense enough to produce movement, this torque might be considered as resistent. When the crown inclination is out of the play range, generating a binary with sufficient force intensity to produce tooth movement, this torque may be considered active. However, the mathematical application of this concept is difficult, since most manufacturers of orthodontic materials do not disclose the play values existent between their bracket and archwire set, and investigations conducted so far were unable to measure the force reduction. Notwithstanding, the acceptance of this explanation may guide the professional during utilization of rectangular archwires, allowing a more accurate estimate of third order binaries generated between the archwire and the slot.

Concluding remarks

Evaluation of incisor inclination during leveling with different rectangular archwires sizes in cases of compensatory treatments allows the following conclusions:

- In compensatory treatments, the bracket-archwire play, though considered a deficiency in the Edgewise techniques (including the Straight-Wire),

may be considered a factor that allow occlusal correction without undesirable movements, even when using partially individualized brackets;
- Additionally, the accurate indication of bracket-archwire play values by the manufacturer would allow to the orthodontist a more effective torque control in Straight-Wire appliances;
- When using individualized brackets for finishing, leveling with 0.019 x 0.025-in archwire did not promote significant alterations in the maxillary and mandibular central incisors inclinations;

Considering that the difference in play between 0.019 x 0.025-in and 0.021 x 0.025-in archwires is 6.6º (Creekmore)[10] and the difference between regular and individualized prescription for mandibular incisors in the employed prescription[5] is 5º, the following could be expected:

- Active lingual torques early in 019 x 0.025-in archwire leveling if regular or individualized brackets for movement were used, especially in Pattern II patients.
- The use of 0.021 x 0.025 archwires caused changes in inclinations, especially in mandibular incisors, opposite to the compensation direction, despite the employment of brackets with compensatory torques.
- Considering the present conditions of individualized brackets for inclination in the Straight-Wire technique, always allowing the possibility of using rectangular archwires, though not mandatory, it seems obvious the choice of rectangular archwire and brackets with play greater than minimum, such as 0.019 x 0.025-in archwire in 0.022 x 0.030-in slot.

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The influence of sucking habits on occlusion development in the first 36 months

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Objective: The objective of this study was to identify the influence of sucking habits on the occlusal characteristics of the deciduous dentition.

Methods: The initial sample consisted of 86 infants, aged 0 to 3 months. Seven home visits were performed, when and information on breastfeeding practice, nutritive and non-nutritive sucking habits, mouth breathing and dentition development was collected. From the first sample, impressions of the dental arches were obtained from 58 children at the age of 36 months (+2.51SD). Dental casts were obtained and two examiners, trained and calibrated by the Kappa and Pearson Correlation tests, measured several parameters of dental occlusion, such as arch length, depth, and width.

Results: The results showed that bottle feeding before 6 months was associated to an increased mandibular intermolar width (p=0.01). Pacifier use before 6 months was statistically associated to a reduction of the maxillary intercanine (p=0.03) and intermolar (p=0.03) width. In addition to these findings, the increased molar depth of the maxillary arch was associated to loss of lip closure before the age of 12 months (p= 0.03).

Conclusion: According to these results, it could be concluded that sucking habits interfere with the determination of some deciduous occlusal characteristics: pacifier sucking limits lateral-lateral maxillary growth, bottle feeding favors lateral-lateral mandibular growth and open bite development, and the lack of lip closure favors the antero-posterior maxillary growth.

Keywords: Morphogenesis. Dental arch. Sucking behavior. Preventive dentistry.

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How to cite this article: Santos Neto ET, Oliveira AE, Barbosa RW, Zandonade E, Oliveira ZFL. The influence of sucking habits on occlusion development in the first 36 months. Dental Press J Orthod. 2012 July-Aug;17(4):96-104.

Submitted: August 07, 2009 - **Revised and accepted:** April 27, 2011

» The authors report no commercial, proprietary or financial interest in the products or companies described in this article.

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INTRODUCTION

The craniofacial growth and development, including muscles, bones and teeth, has been investigated by scientists over the last years. Based on the functional matrix hypothesis of Moss and Salentjin,[1] one can infer that the breastfeeding process would work as a matrix that provides the biomechanical stimuli ideally necessary for craniofacial development.[2,3] Conversely, nutritive and non-nutritive suction and oral breathing would also work as inadequate functional matrices, misshaping the bone and muscle structures that will form the dental spaces.[4-7]

In this context, as teeth erupt and get in contact with all the relations already established, visible and transitory or permanent alterations start to appear. These alterations end up causing bone and muscle disorders and malocclusion in the child.[8,9]

Nutritive or non-nutritive sucking habits, besides their proven effect on the child's oral health, interfere with the child's general health status, leading mothers to adopt practices that are deleterious to the health of newborns, such as the reduction of breastfeeding duration,[10] triggering a series of health risks and also increasing the risk of death.[11]

Malocclusion is a disorder affecting normal development of the occlusion and has a multifactorial etiology. However, not only biological factors, such as nutritive sucking habits (bottle sucking) and non-nutritive sucking habits (pacifier and finger sucking) determine this relation. Tomita et al[12] affirmed that some socio-economic determinants, such as mother's employment and the occupation of the person in the household who has the highest income, are also indirectly associated with the higher prevalence of pacifier sucking and malocclusion among preschool children.

However, undoubtedly, the biological determinants have the most direct influence in determining the maxillomandibular occlusal relationships. The study carried out by Carrascoza et al[13] investigated the consequences of bottle feeding compared to the orofacial development in breastfed children and found a higher proportion of maxillary atresia among them. In addition, Aznar et al[14] confirmed that pacifier sucking led to a reduction in maxillary arch length, especially in the canine region.

Concerning the non-nutritive sucking habits, the study conducted by Viggiano et al[15] showed that such habits constitute the main factors for the development of altered occlusion/malocclusion and open bite in deciduous teeth, being even more relevant than the type of feeding adopted in the first months of life. Warren and Bishara[9] suggested that a prolonged bottle sucking habit led to a higher prevalence of posterior crossbite and anterior open bite, whereas finger sucking led to a higher proportion of increased overjet, increase in the maxillary arch depth and also an increase in the anterior open bite.

Loss of lip closure as an important muscle activity also appears to be an important factor in the development of malocclusion.[16] The occurrence of such phenomenon is strictly associated with the practice of breastfeeding in the first moments of life[17] and is characterized as one of the first signs of the onset of mouth breathing.[18] Jung, Yang and Nahn et al[19] indicated that the force of closure of the upper lip had a large influence on the angulation of maxillary incisors. Therefore, atrophy due to lack of use of the orbicular oris muscle may have a determining function in craniofacial morphology.

Considering these aspects, the aim of this study was to investigate the influence of sucking habits on the occlusal development by analysis of dental casts of children who were observed from zero to three years of age.

MATERIAL AND METHODS

This longitudinal study was conducted on a cohort of infants who were observed until the age of 36 months. All infants aged 0 to 3 months residing in two coverage areas at the city of Vitória, ES, Brazil were included. There were 43 infants aged from 0 to 3 months, referred by one family health care unit and other 43 referred by two family health care units. The coverage areas were chosen because of their higher mortality rate than the city's rate, which is 13.49 per 1,000 live births.

The sample size was calculated using the sample size formula in order to estimate a proportion. Data on the size of the population of livebirths in 2001 in the city of Vitória (4521 children) and the prevalence of breastfeeding at the age of 151 to 180 days for the year 1999 (74.8%, confidence interval 95% between 72.7% and 76.8%) used in this study were provided by the website http://www.datasus.gov.br. The desired accuracy of 10% and the significance level of 5% were

considered. The sample size found was 73 children. Therefore, the sample of 86 children used allowed a safety margin of 18% to account for possible losses to follow-up. This loss to follow-up by 28 children occurred due to address change or not being found at home after several attempts, but it did not impair the analysis in this study.

The group included all children aged 0 to 3 months referred by community health agents. These children were then visited from November 2003 to May 2004 until they reached the amount established. During this period, four researchers, all dental students at the Federal University of Espírito Santo, divided in pairs, went to the health units and observed the home visits made by the community health agent in the homes of study subjects. In this first contact, mothers received guidance on how to take care of their babies regarding oral hygiene, oral breathing, nutritive and non-nutritive sucking habits, the importance of exclusive breastfeeding for at least 6 months for the biomechanics of craniofacial morphogenesis, as well as the nutritional, immunological and affective aspects passed on to the infant during this act.

After counseling, the mothers were invited to participate in the research. They received information on the nature of the study and the frequency of consecutive home visits. Without exception, all mothers who were visited accepted the invitation spontaneously. Based on this agreement, they were interviewed to fill out the form and signed an informed consent.

The visits took place according to a schedule (initially every 3 months, later every 6 months) and also served as observational control of the adherence to the guidelines given in the first visit. These observations were made based on the way the mothers behaved towards their babies. At each visit a new form was filled out and a visual clinical examination was carried out in order to observe the changes occurring. Besides, all information given initially was reinforced. The rooms of the house were also analyzed, so that the information given by the mothers was verified.

In an attempt to involve the people who lived with the baby, counseling was given to all people who were present during the home visit. Whenever possible, guidelines were given concerning oral hygiene, removal of dental plaque and tooth brushing of the household children.

Data collection by home visits finished in June 2006, amounting to seven home visits. The study period covered the maximum duration of breastfeeding recommended by the World Health Organization, since the children were 29.4 + 2.5sd months old at the end of the study.

Six months later, when the primary dentition occlusion was expected to be established, the children were contacted and their mothers or caretakers were invited to take them to the outpatient pediatric dental clinic of the Federal University of Espírito Santo. Mothers were interviewed again and impressions were taken for dental casts making. A new informed consent was taken because the impression was considered a more invasive procedure.

Breastfeeding duration variables was defined as the number of months during which the child was breastfed, directly from the breast or indirectly, regardless of being fed on solids or liquids.[20] This variable was defined by asking at each visit whether the child was still being breastfed or not. If not, records were made of when breastfeeding had stopped, and breastfeeding duration was calculated.

The records addressed whether those habits existed during the study period, and how long the habits of finger, pacifier and bottle sucking had been practiced. These variables were defined by asking at each visit whether the child had the habit. If yes, records were made of when it started and, in case the habit had been discontinued, when it had stopped, and duration in months was calculated. In addition, analysis of the frequency of habits was considered according to the daily practice, yet assessment of the intensity of habits was based on the often imprecise information provided by the mothers, to establish the hours spent in the habits.

At each visit the mother was asked about the introduction of any food of any nature in the child's diet (fruit, vegetables, smashed or industrialized). If yes, records were made of the month in which the child had started this eating habit and literally what food had been used during the previous 24 hours.

Lip closure was defined at each visit based on observational analysis and the mother's report. If during the examination the child kept the lips sealed and remained with the mouth closed without continuous contraction of the genial muscle, presence of lip closure was registered. The child was considered as "not

having lip closure" if during the home visit he or she remained with the mouth open most of the time and when the mother reported that the child remained with the mouth open most of the time.

Alginate (Alvagel®) and plastic (Morelli®) impressions were made at the dentist's office, under room temperature (~ 20ºC), and were maintained moistened in individual plastic bags with wet cotton, bite impression was registered in wax. The impressions were sent to a specialized laboratory, where the preparation of casts was standardized, from mechanical mixing of plaster to the trimming of casts, in the occlusion previously recorded.

After the casts were obtained, two trained examiners analyzed the occlusion and performed the occlusion measurements on all 58 casts independently in an office, under room temperature (~ 20º C), according to the proposition of Warren and Bishara:[9]

1) Overbite or vertical overlap and overjet or horizontal overlap: the casts were placed on a flat table and the measurements were taken with a caliper (Somet Inox®) and a 0.5mm mechanical pencil (Pentel®).
2) Anterior open bite was registered with the lack of vertical overlap between any of the maxillary and mandibular incisors, without estimating the open bite dimension.
3) Posterior crossbite was registered when two or more posterior teeth, also including the canines, presented an occlusal problem in which the buccal cusps of the maxillary teeth occluded lingually in relation to the buccal cusps of the mandibular teeth. The study considered either unilateral or bilateral posterior crossbites as well as functional crossbites, observed by a displacement of the mandible.
4) Dental arches were classified as follows: type I, when the diastemata were generalized in both arches; and type II, when only primate spaces occurred.
5) The terminal relationship of the deciduous second molar was classified in mesial step, when there was maxillary projection; distal step, when there was mandibular projection; and edge-to-edge relationship when the maxillary and mandibular molars coincided.
6) The lengths of the maxillary and mandibular arches were taken using the Dentaurum® 030395 dry-point drawing compass and a caliper (Somet Inox®) by the addition of 4 consecutive manual measurements which were taken by placing the compass and the caliper on the bone base of each dental quadrant: from the most distal region of the deciduous second molar to the most mesial region of the canine; and from the most mesial region of the canine to the most mesial region of the central incisor.
7) The measurements of maxillary and mandibular intercanine and intermolar widths were performed using the dry-point drawing compass and the caliper, by measuring the widths between the canine cusp tips and between the tips of the distobuccal cusps in the maxillary cast and the tips of the intermesio-buccal cusps in the mandibular cast.
8) The measurement of palatal depth or palatal height was performed using a special three-dimensional Dentaurum® 028353 (Korkhaus) drawing compass by positioning the dry points on the distobuccal cusps of the deciduous second molars, the anterior spacer on the buccal aspect of the maxillary central incisors, and the depth cursor touching the bottom of the palatal vault.
9) The canine and molar depth of the maxillary and mandibular arches was measured by using a cotton string and a caliper by stretching the line more distally bilaterally to the canines and deciduous second molars and measuring up to the most anterior portion of the bone base between the central incisors.

Data were recorded in forms adapted by both researchers, typed in the SPSS for Windows 11.0 statistical program and submitted to Pearson correlation tests for quantitative variables and Kappa test for qualitative variables. Pearson correlation tests showed that the variables measured had a strong and very strong correlation rate, ranging from 0.72 to 0.95, which is considered by Landis and Koch[21] as an excellent standard of correlation. However, the Kappa test did not reveal almost perfect agreement standards, as they were below 0.80. Therefore, in the variables in which these discrepancies were present, the study casts were reassessed and the prevailing diagnosis was chosen by the two examiners together.

When all doubts concerning the diagnosis were solved, only the data of one examiner - first author of the present study - were used to test hypotheses of association between sucking habits and occlusal characteristics.

The Student t test and chi-square test were used to analyze the associations between each variable of sucking habits and all occlusal characteristics analyzed, at significance levels of $p<0.05$ and $p<0.10$.

The research protocol was submitted to the Ethics Committee of the Biomedical Center at UFES and was totally approved in the 43rd ordinary meeting of 25th June, 2003 under CEP registration No. 0020/2003. The informed consent necessary for the study was presented to the parents before development of the research. Authorization for the impression procedure was approved in a new project presented to the aforementioned committee in the ordinary meeting of 28th June, 2006.

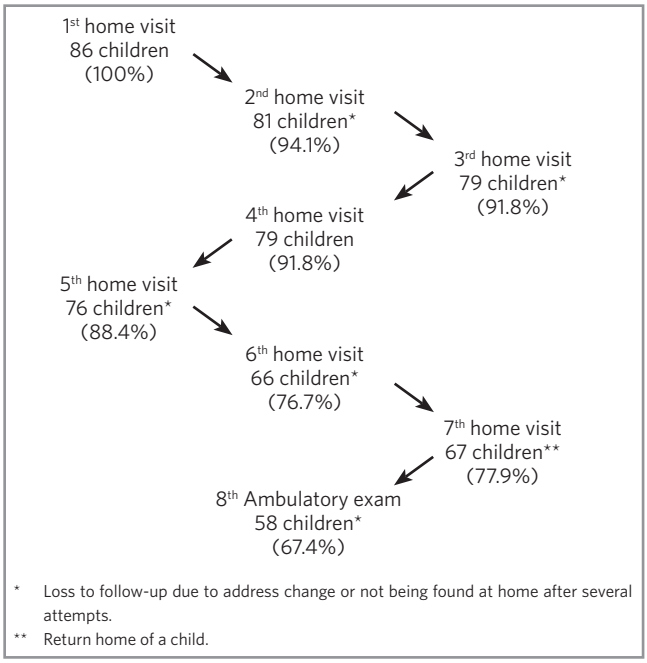


Figure 1 - Cohort dynamics.

RESULTS

Following the random choice of one of the spreadsheets obtained from data collected by the two examiners, it was possible to carry out not only the description of the diagnostic examinations but also an inferential statistical analysis, which was related to the habitual characteristics of the children collected at study onset.

Table 1 shows the means and standard deviations of measurements. Additionally, the length of the mandibular arch presented the highest standard deviation, showing that this length had the greatest variability among the children studied.

Figure 2 describes the relative frequencies of the diagnoses established. The prevalence of normal standards in the deciduous dentition could be seen, as more than 80% presented absence of open bite and crossbite, more than 60% presented arches with type I generalized diastema, and more than 50% exhibited an edge-to-edge terminal relationship of deciduous second molars.

The significant associations between the measurements taken and the habits of children are shown in Table 2 according to the student t test. In this context, it may be observed that breastfeeding for at least 12 months possibly contributed to the increase of the mean palatal depth in relation to children who were breast-fed for longer periods, yet the analysis did not allow to definitely state this association.

Table 1 - Descriptions of measurements in mm of the dental casts of 36-month-old children, Vitória, Brazil, 2007.

Variable	n	Mean	SD
Overjet	58	3.0	1.7
Overbite	58	2.8	1.4
Perimeter of the upper arch	58	74.7	4.3
Perimeter of the lower arch	58	67.9	2.7
Upper intercanine distance	58	30.3	1.9
Lower intercanine distance	58	23.8	1.7
Upper intermolar distance	57	43.5	2.3
Lower intermolar distance	58	37.2	1.9
Palatal depth	57	12.8	1.3
Canine extension of upper arch	58	11.8	1.6
Canine extension of lower arch	58	7.7	1.0
Molar extension of upper arch	57	29.1	1.8
Molar extension of lower arch	58	25.2	1.7

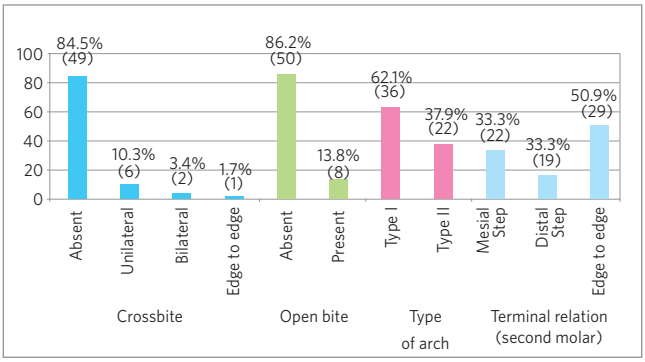


Figure 2 - Relative frequency of occlusal alterations according to analysis of dental casts of 36-month-old children, Vitória, Brazil, 2007.

However, the increase in the length of the mandibular arch was not associated to the introduction of semi-solid foods before five months of age and bottle feeding before 6 months of age. Moreover, bottle feeding also contributed to the increase in mandibular intermolar widths, and this difference was statistically significant.

The c^2 tests of association found only two relevant associations. Bottle feeding before 6 months of age was a statistically significant factor concerning the development of anterior open bite, not associated with the development of type I arch (Tab 3). However, there were very similar proportions of bottle feeding before 6 months of age among children with type II arch.

Table 2 - Student's *t* test for association between nutritive and non-nutritive sucking habits and the measurements taken from dental casts of 36-month-old children.

Variable	Groups	n	Mean	SD	Student's *t* test	p value
Breastfeeding (12 months or more)						
Palatal depth	Yes	36	12.53	1.43	-1.90	0.06
	No	21	13.21	1.09		
Semisolid feeding (before 5 months)						
Perimeter of the upper arch	Yes	21	68.79	2.47	1.89	0.06
	No	37	67.43	2.70		
Pacifier use (before 6 months)						
Upper intercanine distance	Yes	30	29.78	1.97	-2.23	0.03*
	No	27	30.89	1.74		
Upper intermolar distance	Yes	30	42.90	2.11	-2.19	0.03*
	No	26	44.19	2.29		
Bottle feeding (before 6 months)						
Perimeter of the lower arch	Yes	38	68.33	2.71	1.71	0.09
	No	19	67.05	2.55		
Lower intermolar distance	Yes	38	37.64	1.93	2.60	0.01*
	No	19	36.29	1.69		
Loss of lip sealing (before 12 months)						
Overjet	Yes	14	3.96	1.78	2.63	0.01*
	No	44	2.64	1.60		
Molar extension of upper arch	Yes	14	30.04	2.02	2.25	0.03*
	No	43	28.85	1.61		

* Statistically significant values ($p < 0.05$).Other significant values ($p < 0.10$).

Table 3 - Chi-square test for association between nutritive and non-nutritive sucking habits and measurements taken from dental casts of 36-month-old children, Vitória-ES, 2007.

		Bottle feeding (before 6 months)			
		Yes	No	χ^2	p value
Open bite	Absent	32 (80%)	18 (100%)	Fisher	0.04
	Absent	8 (20%	0 (0%)		
	TOTAL	40 (100%)	18 (100%)		
		Yes	No		
Type of arch	Type I	28 (70%)	8 (45.5%)	3.44	0.06
	Type II	12 (30%)	10 (55.5%)		
	TOTAL	40 (100%)	18		

DISCUSSION

Conceptually, it is reasonable to think that determination of craniofacial standards, either normal or pathological, is influenced by a wide range of factors which interact resulting in deciduous occlusal morphology. These factors include socioeconomic determinants, breastfeeding and feeding practices, nutritive and non-nutritive sucking habits, respiratory and functional factors, as well as environmental, behavioral and biological-genetic intrinsic factors.[12,22]

As for descriptive aspects, the means of the measurements of intercanine, maxillary molar and mandibular molar widths found in this study are very close to those found by Aznar et al,[14] whereas the frequencies of crossbite and open bite are similar to those reported by Karjalaimen et al.[23] Other researchers consider that the intercanine distance is an important factor to anticipate the occurrence of crossbite.[24]

Regarding breastfeeding practices, the association between breastfeeding for 12 months and a reduced palatal depth suggests that breastfeeding is a key element for craniofacial development. In the study carried out by Viggiano et al,[15] breastfeeding was considered a protective factor to avoid the development of posterior crossbite in the deciduous dentition, whereas Peres et al[22] showed that breastfeeding for less than 9 months is a risk factor for the development of open bite. However, Warren and Bishara[9] compared the palatal depth between four groups according to breastfeeding duration. Within this context, breastfeeding would favor palate formation, thus influencing a harmonious growth of maxillary bones and attenuating the formation of the deep high-arched palate.

The nutritive sucking habits, represented by the variable of bottle feeding before 6 months, were significantly associated with the occurrence of anterior open bite yet were not associated with type I arch, with generalized diastema. However, Viggiano et al[15] found that non-nutritive sucking habits, more than the type of food given to children in the first months of life, is the main risk factor for the development of altered occlusion and open bite in deciduous teeth. The study conducted by Charchut, Allred and Needleman suggested that predominant bottle feeding for children aged 12 to 18 mouths was associated with open bite,[25] whereas Peres et al[26] concluded, by a multivariate analysis, that pacifier sucking between 12 months and five years of age and finger sucking appear as risk factors for the development of open bite, becoming risk factors for the development of posterior crossbite when combined with a shorter breastfeeding period.

Aznar et al,[14] however, found significant association between shorter maxillary intermolar width and bottle feeding compared to children who were not given a bottle. Carrascoza et al[13] showed that maxillary atresia was present in 22% of children who were given the bottle and were also breast-fed. These results evidence the effect of bottle feeding on the maxilla and not on the reduction of mandibular intermolar width and increase of mandibular length, as shown in the present study.

Based on these studies, it can be suggested that bottle feeding can interfere with both dental arches. However, the isolated effect of bottle feeding on craniofacial development is not well defined, which encourages the accomplishment of both experimental and population-based studies.

Other studies correlated thumb sucking and pacifier use and bottle feeding with increased overjet and open bite.[16,25] This can be explained by the recent shaping of the dental arches which were not exposed long enough to the functional load applied on the teeth during the practice of those deleterious habits. Considering the duration period at 12, 24, 36 and 48 months, Warren and Bishara[9] found that pacifier and finger sucking habits were associated to the reduction or increase of various mandibular and maxillary measurements.

Regarding pacifier use, its harmful effect on the duration of breastfeeding, which precipitates several consequences for the child's general health status, is suggested from the literature. However, its specific deleterious effect on the occlusal development is noticed mainly in the maxillary dental arch. Aznar et al,[14] in a study conducted on Spanish children, found that pacifier sucking habit led to a significant reduction of the intercanine and intermolar mean width in the maxillary arch. Very similar results were confirmed in the present study. Warren and Bishara,[9] however, associated the groups of children who used pacifier for a longer period with a shorter intercanine width in the mandibular arch. Although it was not detected in the present study, pacifier sucking habit is well known in the scientific literature as a risk factor for the

occurrence of anterior open bite[7,9] and increased overjet.[25] This occlusal alteration, in turn, has been associated with the occurrence of deviations in the cervical spine which affect the quality of life of the subject.[27] As one may notice, the use of pacifier had a direct effect on the maxilla favoring its early narrowing, as observed by the smaller means of maxillary intercanine and intermandibular widths in children who used the pacifier before 6 months of age.

With regard to the influence of respiratory alterations on occlusion, Menezes et al[28] studied a sample of one hundred and fifty 8-to-10-year-olds and observed a significant frequency of facial alterations, such as high-arched palate and anterior open bite in mouth breathers compared to nose breathers. Aznar et al,[14] however, concluded that mouth breathing appeared in association with a reduction of the sizes of both arches, and this reduction was more significant in the maxillary intercanine width. Ogaard, Larsson and Lindsten[24] concluded that pacifier use influences the maxillary and mandibular intercanine distances. However, in the present study, loss of lip closure was considered the earliest sign indicating the onset of mouth breathing,[18] which was significantly associated with increased overjet and increase in the molar depth of maxillary arch, suggesting the effect of absence of anterior lip closure on the anteroposterior maxillary growth.

Jung, Yang and Nahn et al[19] indicated that the force of upper lip closure had significant influence on the angulation of the maxillary incisors. Therefore, atrophy due to lack of use of the orbicular oris muscle (loss of lip closure) seems to be an important factor in the development of malocclusions. Variables related to phonetic and functional alterations which can act as co-factors in the determination of dental arches were not considered either.[4]

In face of these considerations, the inclusion of variables related to morphogenetic and functional standards (related to speech and the function of orofacial muscles) would be necessary in order to increase the level of the scope of the study.

Considering these aspects, it is necessary to demonstrate that follow-up studies are rare and difficult to perform, yet provide greater scientific evidence. In addition, this study promotes a new position for early intervention in the oral health of children by preventive strategies to reduce or eliminate mouth habits and consequently avoid malocclusions in permanent dental arches.

CONCLUSIONS

Nutritive (bottle feeding) and non-nutritive (pacifier use) sucking habits and the loss of lip closure were also associated with occlusal characteristics, even if they were introduced or started at an early age.

The time of initiation and cessation of bottle feeding and the duration of such practices showed evidence of association in the determination of occlusal development.

From these results, it could be concluded that sucking habits interfere with the determination of some deciduous occlusal characteristics: pacifier sucking limits lateral-lateral maxillary growing, bottle feeding favors lateral-lateral mandibular growth and open bite development and the absence of lip closure stimulates the anteroposterior maxillary growth.

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Evaluation of disinfection methods of orthodontic pliers

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Introduction: In recent years, a strong behavior change regarding the control of cross infection during dental treatment was perceived, except among some orthodontists who insist in the misconception that Orthodontics is a specialty of low risk in the transmission of infectious and contagious diseases.

Objective: The objective of this study was to evaluate the methods used by orthodontists for disinfection of pliers in their daily practice.

Methods: The bacteria *Pseudomonas aeruginosa*, *Staphylococcus aureus* and *Streptococcus salivarius* were inoculated in vitro in 30 orthodontic pliers. The pliers were divided into 3 groups (n = 10) and disinfected in different ways. Group 1: Brush, soap and water; Group 2: Cotton soaked in ethyl alcohol 70%; Group 3: Immersion in a solution of 2% glutaraldehyde for 30 minutes and then rinsed with water.

Results: The results showed that the ethyl alcohol 70% (Group 2) kept 20% of the pliers infected, being more efficient than the soap and water (Group 1), which maintained 60% of contaminated pliers. Only immersion in 2% glutaraldehyde was able to decontaminate all pliers and was statistically superior to the aforementioned methods (p = 0.030).

Conclusion: Based on these results, we concluded that among the tested methods, disinfection of orthodontic pliers with 2% glutaraldehyde is the only efficient method.

Keywords: Disinfection. Pliers. Orthodontics. Alcohol. Glutaraldehyde.

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How to cite this article: Almeida CMF, Carvalho AS, Duarte DA. Evaluation of disinfection methods of orthodontic pliers. Dental Press J Orthod. 2012 July-Aug;17(4):105-9.

Submitted: September 1, 2008 - **Revised and accepted:** March 2, 2009

» The authors report no commercial, proprietary or financial interest in the products or companies described in this article.

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INTRODUCTION

The interest in developing methods for controlling the infection of diseases is not new. Since the 70's, with the significant increase of cases of hepatitis B and Acquired Immunodeficiency Syndrome, the recognition of the importance of scientific research and strictness in the standards infection control was recognized.[14]

The practice of General Dentistry, and Orthodontics in particular, is characterized by high turnover of patients and variety of vehicles for transmission of infectious and contagious diseases.[4] The negligence in cross infection control puts this area of Dentistry in second place for hepatitis B contamination.[10]

According to the American Dental Association (ADA), it is estimated that dental professionals and patients may be affected by around 40 different types of infectious diseases, when in routine clinical procedures.[12] All infectious diseases are initiated from the body exposure to pathogenic microorganisms. The use of gloves, masks, goggles and aprons is proven essential in all procedures that put in contact the instruments and body parts of the orthodontic team, with secretions or blood from patients, and to avoid the risk of cross infection.[7]

Orthodontics works with younger patients when compared to other specialties. With this thought, some orthodontists are reckless in controlling cross-infection by treating a group of low risk of inoculation of several diseases, besides considering orthodontics as a non-invasive specialty.[18] This thought is a big mistake, because the patients attending the orthodontic clinic are 21% children (1-10 years), 52% adolescents (11-18 years) and 27% adults (older than 18 years), i.e. formed mainly by adolescents and adults. And orthodontists see blood in the patient's mouth at an average of ten times a week, meaning that Orthodontics cannot be considered as non-invasive.[18]

The main guide to achieve effective results in infection control is not to disinfect when you can sterilize.[10] Sterilization is the destruction or removal of all forms of life, including spores, while disinfection is the inhibition or destruction of vegetative forms, not destroying spores and some resistant pathogenic microorganisms.[8]

Traditionally, inadequate methods of infection control have been adopted in a few orthodontic offices.[16] The main justification for the professionals who do not have an infection control program inside the office, is that this procedure takes time and money.[10] Moreover, for a long time there was a concern that the heat or chemical substances could damage the instrument permanently, which undoubtedly contributed to the questioning of the method to be used for material sterilization.[1]

Given the need to improve infection control in orthodontic practice, especially when it comes to pliers, this study aimed to evaluate the real effectiveness of the methods commonly used by orthodontists for disinfection of pliers in their daily practice.

MATERIAL AND METHODS

The efficacy of disinfection methods of orthodontic pliers used in everyday practice by orthodontists was evaluated, using 30 sterile pliers, polished, from various brands, contaminated *in vitro* with bacteria commonly found in the oral cavity, *Streptococcus salivarius, Staphylococcus aureus* and *Pseudomonas aeruginosa*.

The microorganisms were grown in three separate test tubes containing BHI broth (brain and heart infusion) and incubated at 37° C/24h. After this period, the three stocks were mixed in equal quantities and homogenized.

Contamination of 30 orthodontic pliers was performed, through total immersion in broth. After drying this broth, on the surface of each plier was placed a sterile aluminum foil mask, 10 cm x 4 cm, with a hole of 5 cm x 0.7 cm, to standardize and determine the location of collection of the microorganisms (Fig 1). A sterile swab moistened with saline solution for 15 seconds swept over the entire surface of each plier defined by the aluminum foil mask, was used for the collection of microorganisms. The swab was inserted into a test tube containing 2 ml of saline solution and stirred for one minute. From this suspension three dilutions in 0.9% saline solution (1:10, 1:100, 1:1000) were prepared. The seeding was performed from the undiluted suspension and its dilutions: 0.1 ml of each individual solution was transferred to the surface of plates containing selective and differential media. Mitis salivarius agar medium to isolate *Streptococcus salivari,* MacConkey agar medium for the isolation of *Pseudomonas aeruginosa* and Baird Parker Agar

medium for the isolation of *Staphylococcus aureus* were used. This material was spread on the surface of the media prepared in disposable petri plates, using sterile Drigalski handle. After seeding, plates were incubated at 37° C for 48 hours.[5]

Soon after the first collection of these microorganisms of 30 pliers, they were randomly divided into three groups, with 10 pliers each, to receive disinfection treatment as follows:

a) Group 1 (rinsing): Pliers were individually rinsed for one minute with the aid of a sterile brush for each plier, using water and coconut soap bars (n = 10).
b) Group 2 (70% alcohol): A sterile cotton swab soaked with 70% ethyl alcohol was rubbed on each individual pair of pliers for a minute (n = 10).
c) Group 3 (sodium 2% glutaraldehyde): Pliers were fully immersed in 2% glutaraldehyde for 30 minutes and then rinsed with running water (n = 10).

After disinfection treatment of all pliers, new samples were performed, in its surface as described above, but carrying out the collection in a different location.

After the incubation period, microorganism counting on the sown petri plates was performed, before and after disinfection treatment, with the aid of manual colony counter Phoenix CP 608 (Phoenix Industry and Trade of Scientific Equipment LTDA, Araraquara, Brazil). In accordance with standard microbiological techniques the plates containing between 30 and 300 colonies of bacteria were selected for reading.

STATISTICAL ANALYSIS

The significance of the results presented in this research was analyzed by the Mann-Whitney test, which is a non-parametric test, and also the chi-square test.

The Mann-Whitney test was conducted to determine whether the amount of pliers effectively decontaminated is greater than the amount of contaminated pliers. Hence, one-tailed test was carried out with 5% of significance, which gives a coefficient of 95%.

The chi-square test was performed to verify whether the results obtained with the treatments were independent or not from the type of treatment adopted. Thus, two-tailed tests were performed at 5% of significance, as the Mann-Whitney test.

RESULTS

After evaluation of bacterial growth in culture medium (MacConkey Agar, Baird Parker agar, Mitis Salivarius agar) it was verified that all pliers had more than 300 colony forming units (CFU) prior to disinfection treatments. This count aimed to prove that there was contamination.

After disinfection treatment of orthodontic pliers, it was possible to get the results presented below, in a descriptive manner in graphs and tables.

Table 1 presents the values of pliers contaminated and decontaminated (removal of all bacterial colonies) after treatment with disinfectant soap and water, ethyl alcohol 70% and 2% glutaraldehyde.

According to Table 1 it can be verified that:

a) Twenty-two pliers were decontaminated and ten remained infected.
b) The solution with water and soap had good results in only four of the ten treated pliers.
c) All pliers undergoing treatment with a solution composed of glutaraldehyde were decontaminated.
d) The solution based on 70% ethyl alcohol decontaminated eight of pliers undergoing treatment.



Figure 1 - Window for collecting microorganisms.

Table 1 - Number of investigated pliers, according to the disinfection treatment.

Treatment	Decontaminated after disinfection	Contaminated after disinfection	Total
Water and Soap	4	6	10
Ethyl Alcohol 70%	8	2	10
Glutaraldehyde 2%	10	0	10
TOTAL	22	8	30

As for the treatment and bacteria, the results are shown in Table 2.

Regarding the amount of colonies found in eight pliers that remained contaminated even after having been submitted to treatment, it was found that:

a) All pliers that remained contaminated presented colonies of Staphylococcus.

b) From the pliers that remained contaminated, none presented colonies of Streptococcus.

Table 2 - Amount of pliers investigated after treatment according to the kinds of bacteria and treatments.

Bacteria	Water and soap		Ethyl alcohol		Glutaraldehyde	
	Dec.	Cont.	Dec.	Cont.	Dec.	Cont.
Streptococcus	10	0	10	0	10	0
Pseudomonas	5	5	8	2	10	0
Staphylococcus	4	6	8	2	10	0
TOTAL	19	11	26	4	30	0

DISCUSSION

The disinfection methods tested in this study were: Rinsing with soap and water, ethyl alcohol 70% and 2% glutaraldehyde. Table 1 shows that, after treatment with soap and water of contaminated orthodontic pliers *in vitro*, there was a slight reduction in the amount of bacteria present on the surfaces of the pliers.

Only Streptococcus were completely eliminated, Pseudomonas and Staphylococcus were found in significant amounts. These results show the inefficiency of this method as a low-level disinfectant, which can be explained by Chu et al,[6] who said that despite the rinsing procedure being effective in reducing microbial levels deposited the instruments after use, recontamination process may occur resulting in increasing the number of microorganisms. However, our result is at disagreement with Carvalho et al,[5] that disinfected rubber toys from pediatric dentistry offices with soap and water and obtained full decontamination of toys. The results of this study showed that there was no decontamination of pliers post-disinfection treatment with 70% ethyl alcohol, showing the inefficiency of this method as an intermediate level disinfectant (Table 1). Only Streptococcus were completely eliminated, Pseudomonas and Staphylococcus were found in significant amounts. This result can be explained by the fact that alcohol has quick evaporation, not allowing a further reduction in the number of colonies. This result is consistent with the results obtained by Silva and Jorge[17] who used ethyl alcohol 77% in surface and did not obtain a complete decontamination and Navarro et al,[16] who did not obtain complete disinfection of orthodontic pliers using iodized 70% alcohol. Guimarães Junior[11] said that ethanol is not approved by the ADA as a surface disinfectant or immersion. And he goes further by stating that its use is not recommended for disinfecting surgical instruments because of their poor sporicidal activity and its incapacity to penetrate protein-rich materials, although it is tuberculocidal, fungicidal and virucidal, it excludes the hydrophilic, such as hepatitis viruses. However, our result do not agree with Carvalho et al,[5] and Knorst et al,[13] who achieved complete disinfection of rubber toys using 70% ethyl alcohol.

The glutaraldehyde solution is an efficient disinfectant or sterilizing method, depending on the time in which the objects are immersed in this solution. Table 1 shows that after the disinfection treatment with 2% glutaraldehyde, the bacteria were completely eliminated from the surfaces of orthodontic pliers. Results of this study showed the efficiency of 2% glutaraldehyde as a disinfectant agent when the objects are immersed for 30 minutes, since the minimum time of contact with glutaraldehyde to effect the high-level disinfection is 30 minutes according recommendations from manufacturers.[2] It is noteworthy that there was no presence of spores or virus resistant to disinfection, such as hepatitis, in this experiment. Therefore, it is fair to say that glutaraldehyde is one effective method of disinfecting, in 30 minutes, against all pathogens. This result is in agreement with Chapman et al,[5] who disinfected rubber toys with the use of glutaraldehyde and Freitas et al[9] who, reported that glutaraldehyde at room temperature is effective in destroying vegetative forms of pathogenic microorganisms, influenza viruses, enteroviruses and tuberculosis bacilli when immersed for 10 to 30 minutes. The authors went further by claiming that glutaraldehyde is effective against highly resistant spores for a period of 6 to 10 hours. The 2% glutaraldehyde solution is chosen for disinfecting instruments. It is the only one who acts in the presence of organic matter.

It is fungicidal, virucidal and bactericidal in 30 minutes and sporicidal at 10 hours.[10] However, it is believed that the 2% glutaraldehyde can destroy vegetative bacteria in less than two minutes and sporulated bacteria in three hours.[11] Myers[15] disagrees, and says that glutaraldehyde is not recommended because the process takes ten hours of exposure, the efficiency is difficult to monitor, it causes skin irritation, is toxic, discolors and has a corrosive effect on metals. The Ministry of Health[3] recommended an exposure of ten hours for proper sterilization.

After this work, it was found that the disinfection is not a substitute for sterilization, as found in virtually all papers researched. All materials that can be sterilized should never suffer disinfection alone.

Given the above, the need to improve control of infection in orthodontic practice, especially in relation to pliers, is indispensable. It is known that currently, the percentage of adult patients in orthodontic clinics is high, which drops the argument used by orthodontists that patients are very young and therefore have a low risk of inoculation of diseases. Besides, Orthodontics is an invasive specialty, differently from what some orthodontists say.[18]

The bacteria used in this experiment were selected due to cause cross-infection via contaminated instruments and have less resistance to decontamination than spores, hepatitis viruses, and AIDS. Therefore, if disinfection treatment used in this study were unable to eliminate them, let alone would they eliminate the pathogens, which are more resistant.

CONCLUSION

According to the results presented above, it can be concluded that:

a) Decontamination of pliers depends on the treatment adopted.

b) The solution with water and soap is the least efficient of the three methods investigated in this work.

c) The glutaraldehyde-based treatment is the most efficient of the three respondents in this study.

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Cytotoxicity of separation orthodontic elastics.

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Objective: To test the hypothesis that there is no difference in cytotoxicity between separating elastics of different manufacturers.

Methods: The present article compared latex elastics (4.0 mm, 4.4 mm and 4.8 mm) of four different manufacturers. The sample was allocated to seven groups of 9 elastics: Group A (American Orthodontics, green color, modules), Groups M1 and M2 (Morelli, blue color, modules and free in pack respectively), Groups M3 and M4 (Morelli, green color, modules and free in pack respectively), Group U (Uniden, blue color, free in pack) and Group T (Tecnident, blue color, free in pack) regarding their possible cytotoxic effects on oral tissues. Cytotoxicity assays were performed using cell culture medium containing epithelioid-type cells (Hep-2 line) derived from human laryngeal carcinoma and submitted to the methods for evaluating the cytotoxicity by the "dye-uptake" test, at time intervals 24, 48, 72 and 168 h. Data were compared by analysis of variance (ANOVA) and Tukey's test ($p < 0.05$).

Results: Results showed statistically significant difference ($p < 0.05$) between group U and all the other Groups (A, M1, M2, M3, M 4 and T) at 24 and 48 hours.

Conclusions: Uniden elastics evoked more cell lysis at 24 and 48 h, although, all brands showed biocompatibility from 72 h onwards.

Keywords: Cytotoxicity. Elastics. Biocompatibility. Orthodontics.

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How to cite this article: Santos RL, Pithon MM, Martins FO, Romanos MTV. Cytotoxicity of separation orthodontic elastics.. Dental Press J Orthod. 2012 July-Aug;17(4):110-4.

Submitted: February 02, 2009 - **Revised and accepted:** August 16, 2009

» The authors report no commercial, proprietary or financial interest in the products or companies described in this article.

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INTRODUCTION

Orthodontic elastics are widely used in orthodontic practice with the purpose of helping orthodontic treatment, and therefore need to be inert to oral tissues. Elastics in contact with the oral mucosa for several hours a day is a situation that may continue for months. Therefore, the question arises about the possibility of toxic substances being released by elastomers, which may be capable of harming the cells.

Latex is constituted of chains of cis-1, 4-poly-isoprene. After obtaining the liquid from latex, it is preserved by the addition of conservants (usually ammonia). When it is manufactured, various substances are added in order to achieve the final properties.[22]

There are variations in the composition of latex elastics, and consequently, there are differences in their properties. This may be one of the reasons why companies produce various sizes to compensate for the variations in physical properties.[1] Depending on how latex is stored, alterations may occur in its composition, as its major limitation is sensitivity to ozone or other systems generating free radicals, such as sunlight which weakens the latex polymer chain.[22] Prevulcanized latex production involves the mixture of latex from the purest and highest molecular weight natural rubber with stabilizers, such as zinc oxide and vulcanized chemical products. The mixture is heated to a temperature of 70°C.[14] Zinc is known to be neurotoxic.[8] Although the zinc released from orthodontic elastics may be swallowed, the results suggest that the use of latex elastics in orthodontics is appropriate.[5]

Natural latex is not in the category of materials generally considered safe.[6,16] Allergy caused by proteins from latex has been well documented,[13] and may present immediate hypersensitivity reactions.[21] Among the reactions caused by orthodontic elastics, there have been reports of the development of stomatitis with swelling, erythematous oral lesions, in addition to respiratory, and systemic reactions, and in extreme cases, anaphylactic shock.[3,18] The prevalence of latex allergy is between 3% and 17%.[20]

Cell culture tests for the evaluation of dental material toxicity are a valid method to enable understanding of their biologic behavior.[16] The aim of the present study was to test the hypothesis that there is no difference in cytotoxicity between separating elastics of different brands.

MATERIAL AND METHODS

Samples of intraoral latex separating elastics (4.0 mm, 4.4 mm and 4.8 mm) (Fig 1) of 4 different brands and colors were selected (Table 1), and divided into 7 groups containing 9 elastics each: Group A (Green color- modular, American Orthodontics, Sheboygan, Wisconsin, USA), Group M1 (Blue color- modular, Morelli, Sorocaba, Brazil), Group M2 (Blue color- in bulk, Morelli, Sorocaba, Brazil), Group M3 (Green color- modular, Morelli, Sorocaba, Brazil), Group M4 (Green color- in bulk, Morelli, Sorocaba, Brazil), Group U (Blue color- in bulk, Uniden, Sorocaba, Brazil) and Group T (Blue color- in bulk, Tecnident, São Carlos, Brazil) with regard to the possible cytotoxic effect on oral tissues. The elastics used in this research were from the same production lot for each tested color. Copper amalgam was used as positive control (Vigodent, Rio de Janeiro, Brazil), standardized by size and weight, and as negative control, stainless steel wire (American Orthodontics, Sheboygan, Wisconsin, USA) (Table 1).

To conduct this study, HEp-2 (human carcinoma of the larynx) cell culture was used, maintained in Eagle's Minimum Essential Medium (MEM-Eagle) (Cultilab, Campinas, Brazil) with the addition of 0.03 mg/ml glutamine (Sigma, St. Louis, Missouri, USA), 50 µg/ml garamicine (Schering Plough, Kenilworth, New Jersey, USA), 2.5 mg/ml fungizone (Bristol-Myers-Squibb,

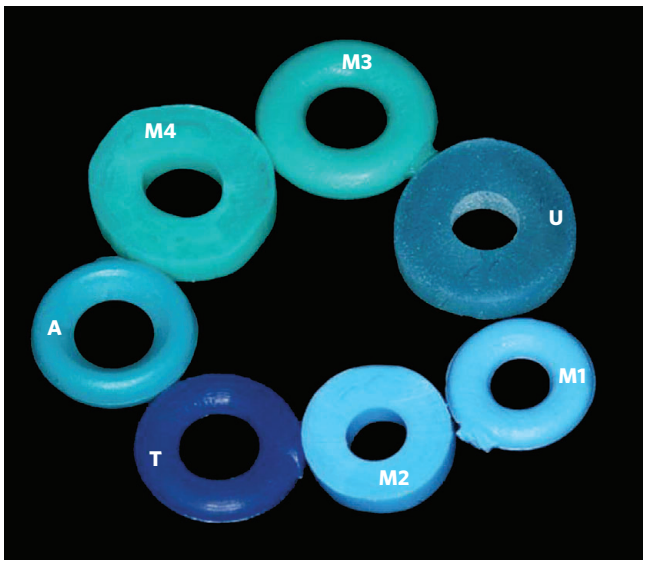


Figure 1 - Separating elastics evaluated in this study: A (green modular, American Orthodontics), M1 (blue, modular, Morelli), M2 (blue, in bulk, Morelli), M3 (green, modular, Morelli), M4 (green, in bulk, Morelli), U (blue, in bulk, Uniden) and T (blue, in bulk, Tecnident).

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New York, USA), 0.25% sodium bicarbonate solution (Merck, Darmstadt, Germany), 10 mM HEPES (Sigma, St. Louis, Missouri) and 10% fetal bovine serum (Cultilab, Campinas, Brazil) (growth medium) or without fetal bovine serum (maintenance medium) and incubated at 37ºC for 48 hours.

The elastics were previously sterilized by ultraviolet radiation (Labconco, Kansas, Missouri) for 30 minutes on each surface of the elastic. To determine the cytotoxicity of the orthodontic elastics, the technique denominated "dye-uptake" was used,[11] which is based on the incorporation of neutral red dye by live cells. The time intervals of 24 h, 48 h, 72 h and 168 h were used, as these elastics are usually maintained in the oral cavity for up to 168 h (7 days) to separate the teeth. This time represents maintenance of the elastic in the cell culture medium for 24 h, 48 h, 72 h, 168 h, and later removal.

Dye-uptake

Volumes of 100 µl of HEp-2 cell suspension were distributed into 96-well microplates. After 48 hours, the growth medium was replaced by 100 µl of culture medium (MEM-Eagle) obtained after incubation with different elastics for time intervals of 24 h, 48 h, 72 h and 168 h. As positive and negative controls the culture media obtained after contact with amalgam and stainless steel wire respectively were used. The experiment was conducted in quadruplicate.

Table 1 - Elastics and control groups used in the tests.

Groups	Brand	Color	Diameter (mm)	Reference
A	A. Orthodontics	Green	4.44	854-251
M1	Morelli	Blue	4.00	60.04.201
M2	Morelli	Blue	4.00	60.04.200
M3	Morelli	Green	4.80	60.04.401
M4	Morelli	Green	4.80	60.04.400
U	Uniden	Blue	4.80	000-1320
T	Tecnident	Blue	4.40	A-007
Positive Control	Copper Amalgam. Pratic NG 2. Vigodent			
Negative Control	Stainless steel wire American Orthodontics. 0.019 x 0.025-in			

After 24 hours of incubation, 100l of 0.01% neutral red (Sigma, St. Louis, Missouri, USA), were added to culture medium in each well of the miniplate, and these were incubated at 37º C for 3 hours for the dye to penetrate into the live cells. After the elapse of this time interval, and after disregarding the dye, 100µl of 4% formaldehyde solution (Vetec, Rio de Janeiro, Brazil) was added to PBS (NaCl 130 mM; KCl 2 mM; Na_2HPO_4 $2H_2O$ 6 mM; K_2HPO_4 1mM, pH7.2) for 5 minutes, to promote cell fixation to the plates. Next, in order to extract the dye, 100µl of 1% acetic acid solution (Vetec, Rio de Janeiro, Brazil) with 50% methanol was added (Vetec, Rio de Janeiro, Brazil). After 20 minutes the readout was taken in a spectrophotometer (BioTek, Winooski, Vermont, USA) at a wavelength of 492nm (λ = 492 nm).

Data were compared by analysis of variance (ANOVA) and afterwards by Tukey's test for evaluation among groups, with reliability at a level of significance of 0.05.

RESULTS

The results showed statistically significant difference among Groups A (Green color- modular, American Orthodontics), M1 (Blue color- modular, Morelli), M2 (Blue color- in bulk, Morelli), M3 (Green color- modular, Morelli), M4 (Green color- in bulk, Morelli) and T (Blue color- in bulk, Tecnident) with Group U (Blue color- in bulk, Uniden) at the time intervals of 24 h and 48 h ($p<0.05$) (Table 2). There was no statistically significant difference between Groups M2, M3, U and T at 72 h ($p>0.05$) (Table 2). At 72 h, the Morelli and Tecnident brands of elastics caused a larger quantity of cell lysis in comparison with the time intervals of 24, 48 and 168 h. This may mean greater release of toxic substances by these elastics in 3 days.

Discussion

In this study, the option was taken to use copper amalgam as positive control and stainless steel wire as negative control (Table 1) as they have been proved to be adequate for this test.[9,12] The cytotoxic potential of dental amalgam comes from the presence of mercury, however, the amalgam contains other substances that

Table 2 - Dye-uptake technique. Statistical description for optical density of elastic evaluated.

Groups	n	Time (24 h)			Time (48 h)			Time (72 h)			Time (168 h)		
		Mean	S.D.	Viable cells (%)	Mean	S.D.	Viable cells (%)	Mean	S.D.	Viable cells (%)	Mean	S.D.	Viable cells (%)
CC	9	0.672^{a}	0.139	100.0	0.557^{a}	0.139	100.0	0.690^{a}	0.149	100.0	0.778^{a}	0.124	100.0
C-	9	0.644	0.149	95.9	0.539	0.149	96.8	0.681	0.131	98.8	0.747	0.120	96.1
C+	9	0.200	0.126	29.8	0.197	0.126	35.4	0.268	0.129	38.9	0.295	0.127	38.0
A	9	0.640^{b}	0.135	95.3	0.526^{b}	0.135	94.5	0.660^{b}	0.131	95.7	0.749^{b}	0.131	96.4
M1	9	0.617^{cb}	0.133	91.9	0.518^{b}	0.133	93.1	0.598^{c}	0.113	86.8	0.728^{cb}	0.130	93.7
M2	9	0.606^{dc}	0.116	90.2	0.517^{b}	0.116	92.9	0.532^{d}	0.126	77.2	0.729^{dbc}	0.120	93.8
M3	9	0.612^{ecd}	0.119	91.1	0.515^{b}	0.119	92.6	0.521^{d}	0.128	75.6	0.719^{ecd}	0.112	92.5
M4	9	0.611^{fcde}	0.123	91.0	0.509^{b}	0.123	91.4	0.489^{e}	0.121	70.9	0.718^{fcde}	0.117	92.4
U	9	0.114^{g}	0.096	17.1	0.068^{c}	0.096	12.3	0.542^{d}	0.089	78.6	0.724^{gcdef}	0.115	93.1
T	9	0.620^{bcdef}	0.122	92.3	0.516^{b}	0.122	92.7	0.544^{d}	0.112	78.9	0.721^{cdefg}	0.119	92.7

Values followed by equal capital letters present no statistically significant difference ($p > 0.05$). CC: Control of cells. C-: Negative Control (stainless steel wire). C+: Positive Control (copper amalgam) and S.D.: Standard Deviation.

may also be neurotoxic, depending on its composition and manufacturer.[8]

Sterilization is a pre-requisite for the cytotoxicity test. Autoclave sterilization may be used, however, elastics have been shown to darken and harden after this type of sterilization due to the heat liberated,[23] which may cause degradation and the release of substances that are toxic to cells. In this study, sterilization by ultraviolet radiation was used[15] for 30 minutes on each side of the elastic. In this study the elastics were shown to have the same aspects of color and malleability after UV light sterilization.

With the increasing use of rubber latex as dental material, many cytotoxic factors have been reported.[7] Sulphur and zinc oxide, as conservants, exhibit cytotoxicity, and dithiocarborates, N-nitrosodibutylamine, and N-nitrosopiperidine, which act as antioxidants, are also known to be cytotoxic substances.[4] Holmes and cols[6] verified whether coloring agents used in colored latex manufacture may have any toxic effect. Their results showed that they have low toxicity. Clinically therefore, this effect is harmless.

Although case reports on allergy to latex do not appear frequently, allergic reactions have become somewhat more prevalent with the increase in latex-based products. The majority of allergic reactions[17] have been related to the use of latex gloves, but only 2 cases were related to the use of orthodontic elastics.[10] In the cases related to orthodontic elastics, the presence of small vesicles or acute edema occurred, and the patients complained of burning and itching.

Allergy to natural latex occurs because it contains many types of proteins, and the powder present in the coating of orthodontic elastics function as a vehicle for these proteins. Therefore, from a clinical point of view, the development of elastics without latex is increasingly important.

In this study, the talc was removed before the in vitro studies were conducted, and it is not known whether the talcum powder would have made any difference.

According to Schmalz,[16] the great danger with the use of intraoral elastics with cytotoxic potential would be the fact that the substances released by these would be ingested by the patient, and over the course of time, cause diseases resulting from the cumulative effect of toxic substances. It is known that latex is not a completely biocompatible substance. It may cause allergic reactions[20,22] and generate cross-reactions with foods[2,20] and medications.[19]

As they are widely used materials in the orthodontic clinic, one must be concerned about the cytotoxicity of elastics, particularly the intraoral type that comes into intimate contact with the mucosa, and opt

for materials that have been proved to be biocompatible from this aspect. Previous studies on the toxicity of latex orthodontic elastics used for separating the teeth, both clear and neon, have been shown to be cytotoxic to gingival fibroblasts.[6]

The cytotoxic nature was evidenced after the elastics were exposed to the culture medium. The Uniden brand of separating elastics caused the greatest quantity of cell death in comparison with the other brands evaluated in the time intervals of 24 and 48 h, which suggests the release of toxic ingredients in the first 48 h for this elastic, however, as from the 3rd day, all the elastics demonstrated a less cytotoxic nature.

The percentage of viable cells was obtained by means of comparison of the mean optic density (OD) of the control cells (without coming into contact with the elastics) with the means of OD obtained from the supernatant of the cell cultures that were placed in contact with the elastics, and toxicity was calculated for 50% of the cell cultures (CC_{50}) (Table 2).

Variations occur in the composition of the latex elastics and this may explain the difference in the results obtained among the brands. Although the *in vitro* evaluation does not simulate the oral medium, it is necessary to consider that the elastics are not clinically inert.

CONCLUSION

It could be concluded that:

1) The separating elastics of American Orthodontics, Morelli and Tecnident brands caused a small quantity of cell lysis.
2) The Unident brand of separating elastics cause a large quantity of cell lysis in the time intervals of 24 and 48 h.

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Different strategies used in the retention phase of orthodontic treatment

Vinicius Schau de Araújo Lima[1], Felipe de Assis Ribeiro Carvalho[2], Rhita Cristina Cunha Almeida[2], Jonas Capelli Júnior[3]

Objective: To identify most frequent clinical conducts, considering the following variables: 1) used appliances; 2) time of use; 3) protocol of use in daily hours and evolution with along time; 4) percentage of patients in follow up 1 year after treatment; and 5) most frequent observed relapses..

Methods: It was used a questionnaire distributed to all specialization course of Orthodontics inscribed in the Brazilian Federal Council of Dentistry until October of 2005.

Results and Conclusion: It was obtained 91 valid questionnaires. For data analysis were used descriptive statistics and chi-square for linear tendency and chi-square for linear trend and chi-square for multivariate linear trend. We can conclude that: 1) on upper arch, the most used appliances were Hawley, wraparound and acetate plate; in the lower multi-stranded rod, steel rod not bonded to incisors and rod bonded to the incisors; 2) it was indicated its use for more than 24 months for the upper arch, with a trend toward its less use than in the lower arch; 3) the protocol of use in the upper arch begins with 24 hours/day, reducing after the second year; for the lower arch the protocol of hours/day was kept stable; 4) after 1 year of retention most than 50% of treated cases were re-examined; 5) most common relapses were crowding, giroversion and opening of diastemas.

Keywords: Retention. Relapse. Stability.

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How to cite this article: Lima VSA, Carvalho FAR, Almeida RCC, Capelli Júnior J. Different strategies used in the retention phase of orthodontic treatment. Dental Press J Orthod. 2012 July-Aug;17(4):115-21.

Submitted: September 22, 2008 - **Revised and accepted:** November 24, 2008

» The authors report no commercial, proprietary or financial interest in the products or companies described in this article.

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INTRODUCTION

The retention stage of orthodontic treatment is fairly discussed in the literature and despite all attention deposited in this area, it still is the most difficult stage of orthodontic treatment.

The misunderstanding around undesirable movements that occur in the teeth, as for example, the effects of residual growth, periodontal problems, different occlusal forces and even the controversial role of third molars in the etiology of late crowding of the lower anterior region contribute complicating the management of this stage.[16,17]

Case, Angle and Hawley, reputed personalities in the history of Orthodontics, had already spoken about the orthodontic retention paying attention to professional negligence.[4]

It is difficult to estimate with precision the total hours indicated for patients and for how long they should use retainers, in other words, we are still searching for a protocol to make retention stage more adequate for every case.

LITERATURE REVIEW

Retention is the stage of orthodontic treatment that consists of maintaining the correct position of the teeth after moving them.[11]

According to Case[4] the art of retention will never be as accurate as the science of tooth correction, having little or no control regarding natural influences on teeth.

The main factors related to failure of orthodontic retention are: Hereditary influences; Disrespect to biological limits of dental movement and the use of an inappropriate retention system among others.[3,8,10,11,12]

Clinical experience has shown over the years that retention is achieved with the use of removable and fixed retainers. A fixed appliance for lingual retention, a Hawley removable appliance, as well as the thermoplastic retainer are commonly used.[17]

The thermoplastic retainer was described in 1971 by Ponitz, and consists of a thermoplastic polymer, heated in a vacuum inclusor in such a way that it suits the model of the arch which will be retained. This appliance is durable, esthetic, easy to clean, presents low cost when compared to steel wire with acrylic and require few adjustments after the laboratory manufacture.[7]

The Hawley appliance is one of the most commonly used. It was developed in the 1920's as an active removable appliance. It is composed of retention clips on the molars and a canine to canine buccal arch, with loops for adjustment, embedded in an acrylic palatal portion. The "wraparound" type orthodontic clip is similar to the Hawley, however the buccal arch extends over all upper teeth not needing additional retention clips.[13]

Sauget et al[15] observed the appearance of new contacts points in the occlusion in the retention stage, which would be positive accommodation for the orthodontic treatment. The study compared the Hawley appliance and acetate appliance covering all elements. The Hawley retainer showed a greater number of contact points, but it was not analyzed if these contact points are solid benefits to the occlusion of the patient.

The canine to canine retention in the mandibular arch is often used, employing smooth steel or multifilament wires, bonded only on canines or all elements. This type of retention does not require cooperation, however requires adequate maintenance and hygiene.[1,8]

Canine to canine fixed retainers maintain alignment after orthodontic treatment. However, a 20% failure rate can be expected after 3 years and no evidence of damage to hard or soft tissue adjacent to the wire can be noticed.[2]

There is not a known usage time for using retention, it is only known that at least 232 days are necessary for periodontal fibers to reorganize into the new position.[5] Even if the dental elements are stabilized throughout the period of reorganization of the periodontal fibers, in the long term some relapse will occur. There is no agreement in the literature concerning the duration of the retention period. Some authors defend periods of two to three weeks, even occurring indication of permanent retention.[8,11]

The biggest challenge for the dental stabilization occurs after rotation correction.[5,6,18] Studies in dogs, performed by Reitan[14] histologically demonstrated the persistence of distention of connective tissue fibers in the periodontium of the supracrestal area seven months after the induction of rotation movement.

Edwards[5] produced a simple surgical procedure that alleviated the influence of periodontal fibers that used to rotate the dental element. Campbell, Moore and Mathews named this intervention as circumferential supracrestal fibrotomia.[6]

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OBJECTIVE

To identify clinical procedures used by Orthodontists associated to specialist training centres throughout the national territory, for the following variables:

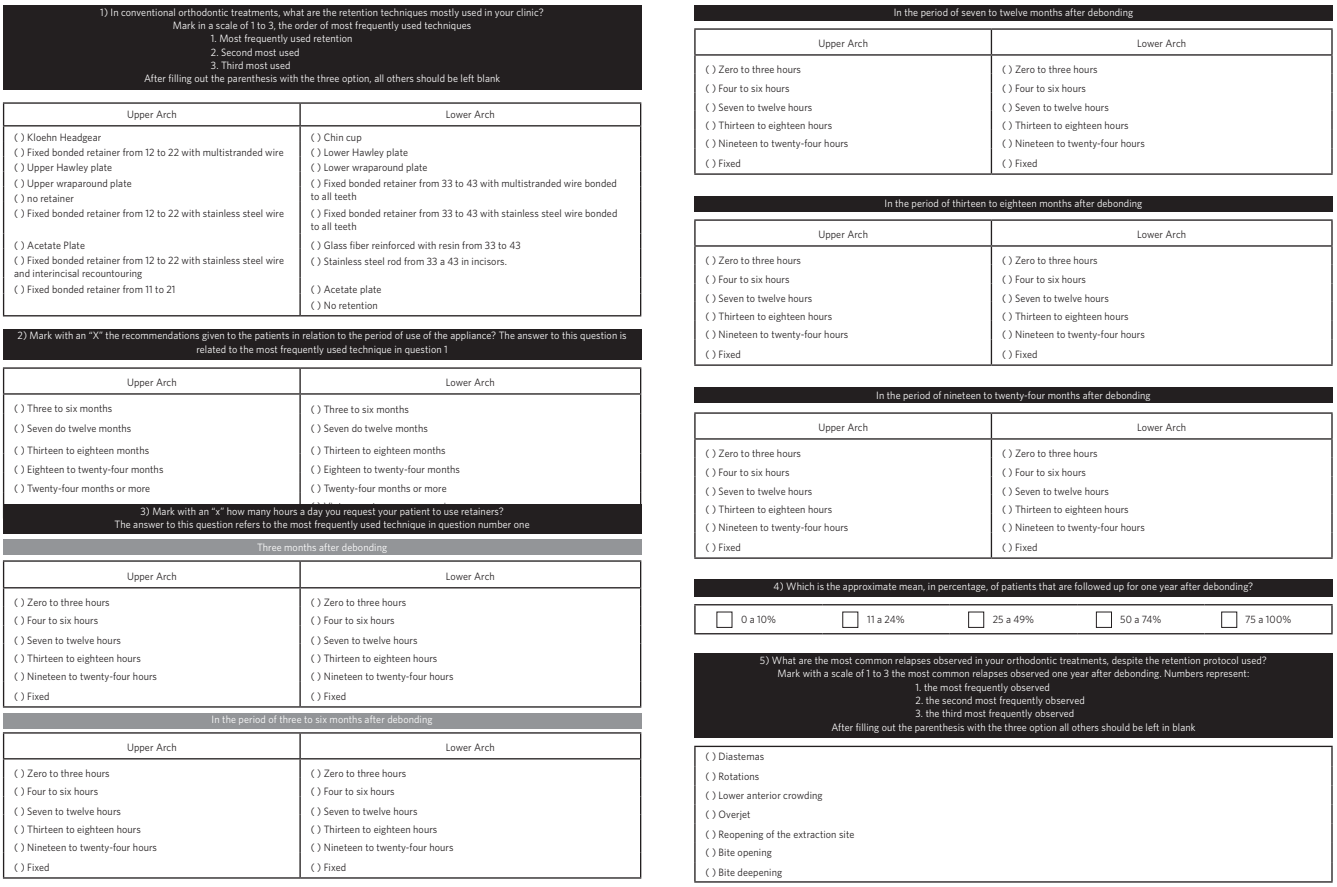
1) Appliances mostly used for the upper and lower arches.
2) Time interval, in months, using the system.
3) Protocol for use, in hours, of retention over the months
4) Percentage of patients monitored by Orthodontists 1 year after the end of active treatment.
5) Most frequently observed relapses.

MATERIAL AND METHODS

A descriptive survey was made whose universe was composed of teachers of specialization courses in Orthodontics and Facial Orthopedics that were accredited and recognized by the Federal Dental Council until October 2005. The listing for these courses was obtained in the catalog of the Brazilian Association of Orthodontist of 2005 and, by e-mail, collected directly from the Federal Dental Council, there was no other criteria for this selection.

A questionnaire was devised and was validated in compliance with formatting and wording rules advocated by Willians,[19] where a simple, clear language vocabulary (avoiding jargon and regional terms), short questions, clear and objective, avoiding phrases with more than 20 words is indicated. This "pilot" questionnaire was distributed to faculty and doctoral students of the institution which coordinated this study, suggested changes were made until everyone involved in the preliminary assessment did not present difficulties in answering the questions in a simple way.

The final questionnaire was sent to all selected courses (n = 226), with an attached letter describing the purpose of this study (Fig 1).



1) In conventional orthodontic treatments, what are the retention techniques mostly used in your clinic?
Mark in a scale of 1 to 3, the order of most frequently used techniques
1. Most frequently used retention
2. Second most used
3. Third most used
After filling out the parenthesis with the three option, all others should be left blank

Upper Arch	Lower Arch
( ) Kloehn Headgear	( ) Chin cup
( ) Fixed bonded retainer from 12 to 22 with multistranded wire	( ) Lower Hawley plate
( ) Upper Hawley plate	( ) Lower wraparound plate
( ) Upper wraparound plate	( ) Fixed bonded retainer from 33 to 43 with multistranded wire bonded to all teeth
( ) no retainer	
( ) Fixed bonded retainer from 12 to 22 with stainless steel wire	( ) Fixed bonded retainer from 33 to 43 with stainless steel wire bonded to all teeth
( ) Acetate Plate	( ) Glass fiber reinforced with resin from 33 to 43
( ) Fixed bonded retainer from 12 to 22 with stainless steel wire and interincisal recountouring	( ) Stainless steel rod from 33 a 43 in incisors.
( ) Fixed bonded retainer from 11 to 21	( ) Acetate plate
	( ) No retention

2) Mark with an "X" the recommendations given to the patients in relation to the period of use of the appliance? The answer to this question is related to the most frequently used technique in question 1

Upper Arch	Lower Arch
( ) Three to six months	( ) Three to six months
( ) Seven do twelve months	( ) Seven do twelve months
( ) Thirteen to eighteen months	( ) Thirteen to eighteen months
( ) Eighteen to twenty-four months	( ) Eighteen to twenty-four months
( ) Twenty-four months or more	( ) Twenty-four months or more

3) Mark with an "x" how many hours a day you request your patient to use retainers?
The answer to this question refers to the most frequently used technique in question number one

Three months after debonding

Upper Arch	Lower Arch
( ) Zero to three hours	( ) Zero to three hours
( ) Four to six hours	( ) Four to six hours
( ) Seven to twelve hours	( ) Seven to twelve hours
( ) Thirteen to eighteen hours	( ) Thirteen to eighteen hours
( ) Nineteen to twenty-four hours	( ) Nineteen to twenty-four hours
( ) Fixed	( ) Fixed

In the period of three to six months after debonding

Upper Arch	Lower Arch
( ) Zero to three hours	( ) Zero to three hours
( ) Four to six hours	( ) Four to six hours
( ) Seven to twelve hours	( ) Seven to twelve hours
( ) Thirteen to eighteen hours	( ) Thirteen to eighteen hours
( ) Nineteen to twenty-four hours	( ) Nineteen to twenty-four hours
( ) Fixed	( ) Fixed

In the period of seven to twelve months after debonding

Upper Arch	Lower Arch
( ) Zero to three hours	( ) Zero to three hours
( ) Four to six hours	( ) Four to six hours
( ) Seven to twelve hours	( ) Seven to twelve hours
( ) Thirteen to eighteen hours	( ) Thirteen to eighteen hours
( ) Nineteen to twenty-four hours	( ) Nineteen to twenty-four hours
( ) Fixed	( ) Fixed

In the period of thirteen to eighteen months after debonding

Upper Arch	Lower Arch
( ) Zero to three hours	( ) Zero to three hours
( ) Four to six hours	( ) Four to six hours
( ) Seven to twelve hours	( ) Seven to twelve hours
( ) Thirteen to eighteen hours	( ) Thirteen to eighteen hours
( ) Nineteen to twenty-four hours	( ) Nineteen to twenty-four hours
( ) Fixed	( ) Fixed

In the period of nineteen to twenty-four months after debonding

Upper Arch	Lower Arch
( ) Zero to three hours	( ) Zero to three hours
( ) Four to six hours	( ) Four to six hours
( ) Seven to twelve hours	( ) Seven to twelve hours
( ) Thirteen to eighteen hours	( ) Thirteen to eighteen hours
( ) Nineteen to twenty-four hours	( ) Nineteen to twenty-four hours
( ) Fixed	( ) Fixed

4) Which is the approximate mean, in percentage, of patients that are followed up for one year after debonding?

☐ 0 a 10% ☐ 11 a 24% ☐ 25 a 49% ☐ 50 a 74% ☐ 75 a 100%

5) What are the most common relapses observed in your orthodontic treatments, despite the retention protocol used?
Mark with a scale of 1 to 3 the most common relapses observed one year after debonding. Numbers represent:
1. the most frequently observed
2. the second most frequently observed
3. the third most frequently observed
After filling out the parenthesis with the three option all others should be left in blank

( ) Diastemas
( ) Rotations
( ) Lower anterior crowding
( ) Overjet
( ) Reopening of the extraction site
( ) Bite opening
( ) Bite deepening

Figure 1 - The final questionnaire sent to the selected graduate courses.

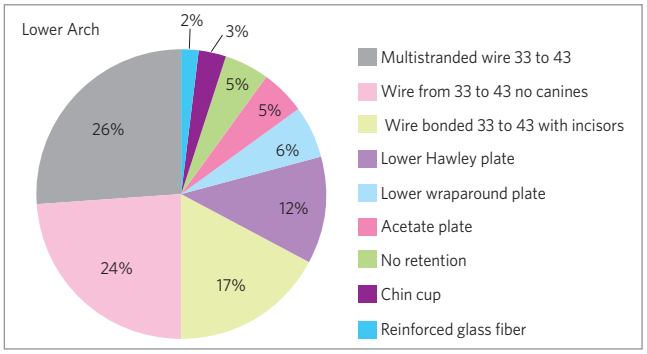


Figure 2 - Main retention techniques used after orthodontic treatment in the lower arch (n = 91).

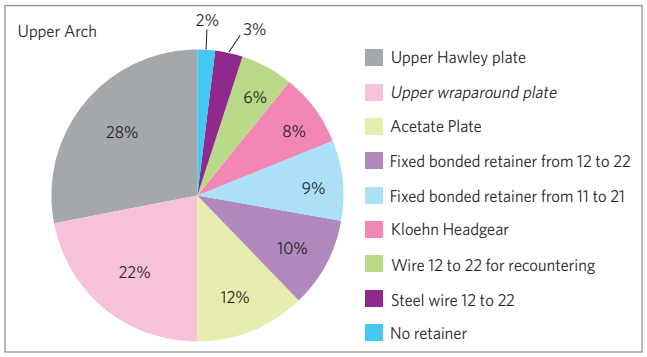


Figure 3 - Main techniques of retention used after orthodontic treatment in the upper arch (n = 91).

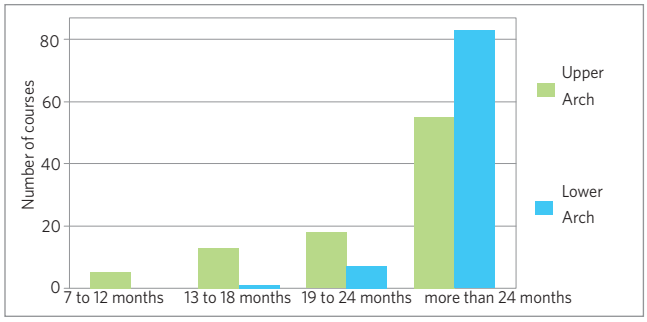


Figure 4 - Period of use of the retainer after orthodontic treatment, between the number of courses (n = 91).

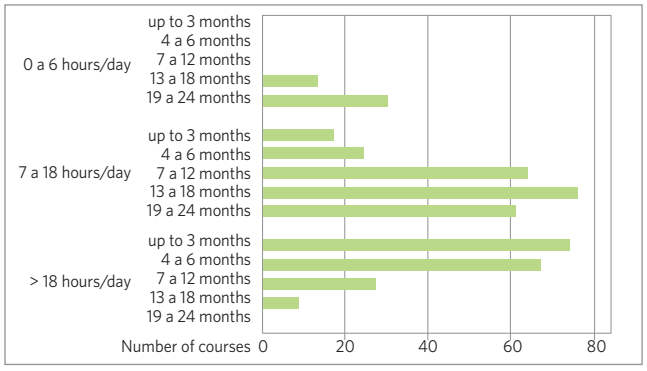


Figure 5 - Hours of daily use of retainer in relation to time (in months) after debonding in the upper arch. Number of courses.

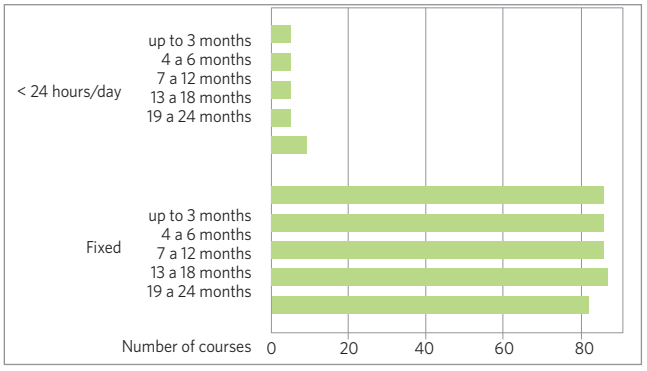


Figure 6 - Hours of daily use of retainer in relation to time (in months) after debonding in the lower arch.

Statistical analysis

The chi-squared test was used for linear trend and multivariate linear trend.

RESULTS

Of the total of the institutions (n = 226), only 183 could be contacted. One hundred and five questionnaires were collected, and of these 23 were returned due to filling in doubts and/or erasures. After these were answered again 14 questionnaires were still with errors and/or deletions, being then excluded, thus 91 valid questionnaires were obtained.

Evaluating if the period of retention use in months, a growing linear trend was observed, evaluated by chi-squared test for linear trend ($p < 0.69$).

It was observed in Figure 4, a trend for later removal of lower retention when compared to upper.

In Figure 5 the number of hours per day of retention appliance use in relation to the number of months after treatment was correlated. There was a linear trend for both variables ($p < 0.00$), demonstrating a decrease in the amount of daily hours of appliance use as time of removal increased

By comparison with the chi-squared test for linear tendency, there was a tendency to maintain the lower arch retainer for over 24 months ($p < 0.33$) (Fig 6).

When the amount of followed up patients was evaluated, a tendency for return of the majority of patients was observed (Fig 7).

Finally, considering the answers referring to the main relapses observed during retention period, the most commonly observed was the lower anterior crowding, with approximately 34% (Fig 8).

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DISCUSSION

Littlewood et al[11] formulated a systematic review to evaluate the effectiveness of different strategies of retention, and concluded that it is not possible to fully assess the effectiveness used to stabilize tooth position after corrective treatment, due to the low quality of studies found in the literature. They emphasized the need for further research in order to obtain concrete evidence on the subject.[11,11]

In this study, the questionnaire were directed to a professor of Orthodontics, which according to Willians[19] would represent a response from the entire group of teachers from the evaluated institution. Ninety-one questionnaires were answered (40.08%), since for a result to be representative of a universe a return of 80% of of valid questionnaires is necessary.[19] However, it is possible to observe in the literature that the percentage of answers in this work was greater than or equal to other researches, such as Kiyak et al[9] that achieved a 41% return rate.

The results of this study found that the Hawley and wraparound plates were the most used in the upper arch,followed by the acetate plate. According to Sauget[15] acrylic apparatus with stainless steel wire are more efficient in retaining tooth extrusion when compared to acetate plate.

Gardner, Dunn and Taloumis[7] describe the Ponitz plate as esthetical, easy to clean, low cost and requires minimal adjustments for placement. However, the acrylic portions of Hawley and wraparound plates are more resistant than the acetate and the metallic portion allows you to correct small dental irregularities as well as it be transformed into bite plates for stabilization of deep bite correction.[4,7]

Such versatility of acrylic appliances with wires probably justifies its greater use by professionals, even having a higher cost and a more elaborate construction compared to lab acetate plates.

The multistranded wire retainers bonded to upper incisors are well indicated in cases of diastemas and in cases with periodontal problems. This type of retention is discreet and does not require patient cooperation. Multistranded wires appeared as the most widely used option, with 18.3% (adding if those bonded to two central incisors and also to the lateral incisors) when compared to stainless steel wire, which also added were in 9.2% of cases.

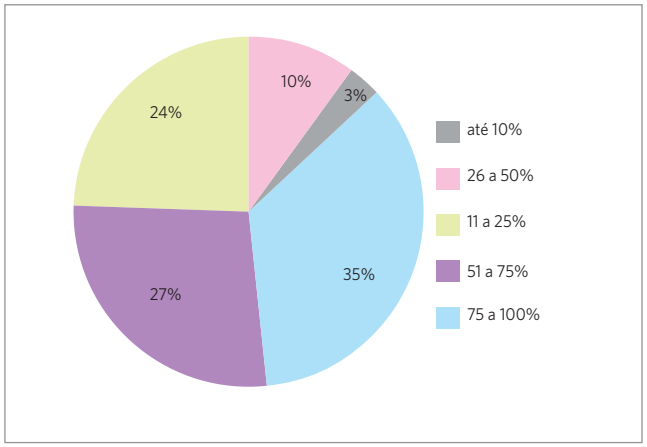


Figure 7 - Rate of patient return after the end of treatment (n = 91).

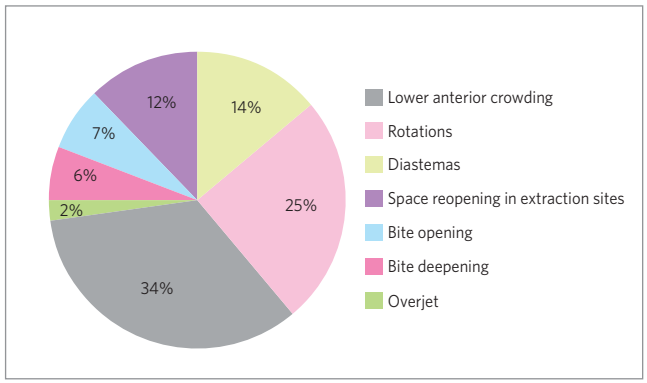


Figure 8 - Major relapse after treatment orthodontic.

It is expected from the multistranded wire to allow a differential movement of the teeth, what is best in cases periodontally committed.[17]

Both multistranded and stainless steel wires can be used concomitantly with other types of retention for the remainder of the arch. Its failure index is 47% particularly when used in cases of deep bite, so the combination of lingual bonded wires with the Hawley and "wraparound" plates can be a good option to decrease the failure rate.[1,11]

In the lower arch canine to canine bonded retainer showed up as the mostly used in the conditions assessed in this study. This fact is due probably to its fixed character, that justifies its employment in a region where most Orthodontists observe relapses.

The use of the canine to canine fixed retainer with multistranded wire bonded to upper canines and incisors was the most cited, probably because you have better composite adhesion[10] and by using a wire that

allows some tooth movement. Artun et al[1,2] however, proved there is no difference between the use of stainless steel and multistranded wires.

Another point of divergence is the duration of use of retention appliances, both for upper and lower arches

According to Silva Filho, Kubitski and Marinho[17] the lower retention should be used for long-term or indefinitely. Reitan[14] in his studies noted that the periodontal fibers remain with memory until 7 months after removal of fixed appliances, which would force the use of appliances, both in the upper and lower arches for 7 months at a minimum for the retention of the fixed orthodontic treatment. The results of this study showed a concern about the use of retention appliances because it was recommended in ,80.2% of answered questionnaires, with use for a period of 19 or more months after removal of fixed appliances for the upper arch, and there is an even greater concern for the lower arch with 98.7% of indications for use for more than 19 months.

Considering the number of hours per day that the retention appliance is used for the upper arch there is a tendency to decrease the duration of the use of the appliance over time, that is, over the months the usage hours decreases, showing a linear trend. The decrease in hours of daily use of retention may be related to a lower need for use, contrary to the findings of Reitan[14] that indicates that the periodontal fibers take 7 months to decrease its effects on orthodontically corrected teeth.

In the lower arch the result of hours used per day presented a trend toward stability, given the continued use by approximately 94% of the professionals in the first 24 months. This result is in agreement with Silva Filho et al.[17]

After lower anterior crowding, the most commonly seen type of relapse was rotation. The diastemas appeared in third place with 14.3%. The diastemas are retained with fixed retainers, widely used in these cases, bonded wires in diastema sites, previously observed by Orthodontists at the time of diagnosis. The reopening of the extraction spaces is also cause for attention. In this study, this wasn't as cited by respondents such as the others. This finding may be biased since only part of the cases is treated with extractions, so ideally there should be a questionnaire covering what would take place only in cases with dental extractions. Silva Filho[17] recognizes this as an important relapse and cites the fixed retainers extended up to pre molars as an option.

Patient control by professionals was examined in order to verify whether the replies obtained were representative of evaluated reality clinic. Of all respondents 62% reported one year follow up of 51% or more of the cases. This finding contributes to the reliability of answers analyzed, because the cases dealt with were followed up after one year for most patients.

CONCLUSION

The present study may conclude that:

1) The most frequently used retainers were in decreasing order for the upper arch: the Hawley plate, the wraparound plate and the acetate plate. In the lower arch: fixed bonded retainer with multistranded wire from canine to canine, fixed retainer with stainless steel bonded only to canines, and stainless steel fixed retainer also bonded to incisors.
2) The recommendation with regard to the use, in months, for the upper arch was 24 months or more, however there is a tendency to be less than the use in the lower arch, that proved to be constant.
3) The protocol for the upper retention use starts normally with 24 hours use, and there is a reduction after the second year to 12 hours daily. For the lower arch the fixed retention was most frequently used, the hours of use was stable, due to impossibility of removal by the patient.
4) After one year of retention Orthodontists examined, over 50% of treated cases.
5) The most commonly observed relapse were: Lower anterior crowding, rotations and reopening of diastemas, in that order.

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Effects induced after the use of maxillary protraction appliances: A literature review

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Objective: The present literature review, examined the effects of maxillary protraction in patients treated with different types of facial masks.

Methods: The review searched for relevant articles, including randomized controlled trials, controlled clinical trials and uncontrolled trials. Comparisons were made between eight different types of facial masks: Delaire; Grummons; Petit; Turley; Batista; "Sky Hook"; Nanda and Türbinger. Following aspects were evaluated: a) the type of anchorage; the origin, direction and magnitude of forces and b) the relevant results of following skeletal and dental measurements: angular (SNA and SNB), linear (AFAI); vertical angles (SN.GoGn, FMA); dental (IMPA) and linear (1-NA, 1-NB).

Conclusion: The results showed that there was no uniformity in the choice of anchorage type and form of application of forces between the facial masks examined, but there were similarities in skeletal and dental aspects: Anterior displacement of the maxillary complex (increase in SNA) ; anterior displacement of the upper anterior teeth (increase of 1-NA), the lingual inclination of mandibular incisors (decrease of 1-NB), down and back rotation of the mandible (increase AFAI, SN.GoGn, FMA, decrease in SNB).

Keywords: Headgear Appliances. Angle Class III malocclusion. Maxilla.

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How to cite this article: Freire AB, Nascimento LEAG, Lira ALS. Effects induced after the use of maxillary protraction appliances: A literature review. Dental Press J Orthod. 2012 July-Aug;17(4):122-8.

Submitted: March 03, 2010 - **Revised and accepted:** October 04, 2011

» The authors report no commercial, proprietary or financial interest in the products or companies described in this article.

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INTRODUCTION

The first treatments relative to Class III malocclusions using facial mask were performed by Potpeschnigg[47] in 1875. In 1971,[9] Delaire established the clinical use and popularization.[15,29,31,36] Over the years, authors[1,11,28,37,43,44,48] modified Delaire's concepts related to: 1) the traction mechanics, increasing the quantity of force applied and reducing the treatment time; 2) the expander, using the acrylic occlusal covering as anchorage; and 3) the patient cooperation, with the use of personalized facial masks.

Within the treatment options for Class III malocclusions the following approaches can be usually found: Inclined plane, chin cap, facial mask, fixed appliances[30] and the Frankel functional regulator III.[12] Hyrax, Haas or McNamara palatal disjunction are appliances used for median palatine suture disjunction (RME), which after accomplished, frees the craniofacial sutures and facilitates the desired anterior movement of the maxilla. Moreover, maxillary splinted teeth are maintained during the post-disjunction period (six to eight months) and used as anchorage for protraction by means of hooks for elastics.[27,38,49]

The indications for protraction are: 1) young patients; 2) well-positioned or lingually inclined upper teeth; 3) normal or decreased inferior facial height;[37,44] 4) Class III malocclusion with anteroposterior (AP) and/or vertical maxillary deficiency;[44] and 5) slight to moderate skeletal Class III malocclusion, with retruded maxilla and hypodivergent growth pattern.[37] The use of reverse pull facial masks are not indicated in patients with increased inferior facial height. A skeletal effect of the mask is an anterior movement of the upper teeth and downward-backward rotation, which contributes to a greater increase of the patient's inferior facial height at the end of the treatment.[17,34,44] The existing devices contain variations in their classification with relation to extra-oral anchorage: a) occipital-mentum support (Sky Hook), b) fronto-mentum support (Delaire, Petit, Turley, Tübinger), c) fronto-infraorbital support (Grummons).[23,26]

Treatment with facial masks for early correction of Class III maxillary deficiency is completely dependent on a good level of cooperation by the patient.[30,31] The growing interest in early treatment of this malocclusion has kindled the necessity of knowing the treatment approaches, types of masks, their mechanisms of action, indications, as well as knowledge of palatine disjunction and its mechanisms. The objective of this research was to perform a comparative study between the various types of facial masks and their dental and skeletal influences and the implications regarding the effect on inferior facial height.

MATERIAL AND METHODS

Literature review

The strategy for this review was based on four data sources and internet gateways (Cochrane Central Register of Controlled Trials, Ovide ALL EMB Reviews, PubMed and Bireme) from January 1965 to May 2011, using the key-words: Class III malocclusion, reverse-pull, facial mask and rapid maxillary expansion. Two of the authors separately searched for additional relevant publications that may have been absent in the data banks (for example: Manual search of scientific articles in libraries and direct contact with the authors). There were no language restrictions. At first, the articles were selected by reading the titles and abstracts. The full text was obtained of publications that fulfilled the inclusion criteria (Tab 1). The selection of each article was evaluated independently, and at the second consensus, a 100% final agreement was obtained between the two authors.

Collection of data

After selection based on the inclusion criteria, the articles were used to compare the effects of eight different models of facial masks: Delaire, Grummons, Petit, Turley, Batista, Sky Hook, Nanda and Tübinger. The following data was selected from each article: a) the type of anchorage; the origin, direction and magnitude of force b) the results pertinent to the alterations in sagittal angles (SNA and SNB) and vertical (AFAI) skeletal measurements; vertical angles (SN.GoGn, FMA); angular (IMPA) and linear (1-NA, 1-NB) dental measurements.

RESULTS

Strategies for literature review

The search strategy resulted in 14 articles[2,3,6,7,8,16,21,25,33,34,40,41,42,50] selected according to the inclusion criteria, which were submitted to a comparison among eight different face mask models: Delaire; Grummons; Petit; Turley; Batista; "Sky Hook"; Nanda and Tübinger.

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Data collection

After evaluating the items: a) type of anchorage; origin, direction and magnitude of force applied (Tab 2), it was verified that besides chin and forehead support, other extra-oral anchorage sites exist for reverse-pull therapy such as midfacial, cervico-occipital-molar and cervico-mentum regions. Canines and molars are used as the origin of the forces, which varied in intensity, inclination and duration in hours per day, as well as not being standardized in treatment duration among the analyzed models.

In the analysis of the results pertinent to the alteration of the sagittal skeletal angular measures (SNA and SNB); dental angular (IMPA) and linear (1-NA, 1-NB) measures, it was observed that with all models there was anteroinferior movement of the maxilla confirmed by the increase of SNA; clockwise rotation of the mandible with decrease in SNB; vestibularization of the upper incisors or compensation of the Class III with increase in 1-NA. With the lower teeth, there was a decrease in 1-NB, lingual inclination or compensation of the Class III (Tab 3).

In the analysis of the results pertinent to the alterations of vertical skeletal (AFAI) and vertical angular (SN.GoGn, FMA) measurements, and increase in AFAI, the SN.GoGn angle with mandibular clockwise

Table 1 - Inclusion criteria for the selection of articles.

Type of search and study	Scientific articles, randomized clinical trial, controlled and non-controlled
Type of sample	Involving humans aged 5-14 years (+/- 0.63 years)
Indications for treatment	Skeletal Class III and anterior crossbite
Type of palatine expander	Hass, Hyrax Cases without disjunction with use of an expanded removable plate with hooks or transpalatal bar
Disjunctor activation protocol	Minimum of 2/4 turns per day or every two days for three weeks
Beggining of loading	Start without disjunction or concurrently with disjunction or upon appearance of interincisal diastema or immediately after palatine disjunction
Variation of force applied	Ranging from 230 to 600g/side
Daily time of facial mask usage	From 6 to 24 hours/day
Total treatment time	From 2.5 to 12 months or until a positive overjet or Class I dental relationship was obtained

Legend: plo = occlusal plane; min = minute; gf = gram force; N = Newton.

Table 2 - Data collected from selected articles showing the differences in type of anchorage, origin, direction and magnitude of the forces.

Mask Model	Type of anchorage	Force Direction		Force Magnitude		
		Origin	Inclination degrees/opl	Intensity/side	Duration hours/day	Duration months
Delaire[2,7,8,42]	Fronto-mentum	Canines	25[7]; 30-40[8]; 45[42]	350 gf[7]; 230-285 gf[8]; 340 gf[42]; 400-600 gf[2]	10-16[7,8]	6-12[7,8,42]
Grummons[21]	Fronto-mid-face	Molars	Anteroinferior	0,5 N	24	8
Petit[2,41,40,50]	Fronto-mentum	Canines	30[40]; 30-40[50]	400-600 gf[2]; 300-500 gf[50]; 600 gf[41]	14-16[2,40,50]	3[50]; 8±2,5[40]
Turley[25,41]	Fronto-mentum	Canines	20-30[25]	400 gf[25] orthopedic[41]	14-20[25,41]	6[25]
Baptista[3,16]	Cervico-occipital-molar	Molars	Anteroinferior[3,16]	415 gf[3]; 500 gf[16]	14[16]	12[3]; 31[16]
Sky Hook[6]	Cervico-mentum	Canines	Anteroinferior	300 cN	12+1 min.	6
Nanda[34]	Fronto-mentum	Molars	15 mm above and parallel to the opl	300-450 gf	12-16	6
Tübinger[33,40]	Fronto-mentum	Canines	30[33,40]	600 gf[40]; 380 gf[33]	12-14[33]; 16[40]	6[33]; 8±2,5[40]

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turn and increase of the FMA angle was noticed as a results of the facial mask types analyzed (Tab 4).

DISCUSSION

Correction of skeletal Class III malocclusion using maxillary protraction therapy results in a combination of bone and dental changes that entail significant improvements in facial profile.[41] In the last few years, this type of therapy became common due to the significant influence of maxillary deficiency within this malocclusion providing useful results for young patients.[50]

It was observed that the majority of facial mask models used fronto-mentum support as extra-oral anchorage with vertical effect mainly for Class III patients with normal or decreased AFAI. The Baptista model, using the lower molar as anchorage and modified headgear, has a pleasant aesthetic effect, but with the high cost of adverse effects on these teeth and considerable limitations in the patient's opening of the mouth and speaking. The Sky Hook and Grummons models have more favorable aesthetic and vertical effects, being the best alternative for patients with increased AFAI.[6,21] The absence of chin support on the Grummons model eliminated the force vector directed backward and upward, acting on the temporomandibular joint, compressing the ligaments and impairing mandibular movements involved in speaking, breathing and deglutition.[21] Aside from fronto-mentum anchorage, the Nanda model uses a vertical chin cup concurrently to reduce effects on AFAI.[34]

For The majority of the models[2,6,7,8,25,33,40,41,42,50] (Tab 2) the canine region was used as the origin of the force to avoid anterior bite opening and to enhance anteroinferior rotation of the maxilla and its influence on the mandibular clockwise rotation,improving the profile.[24,45] This maxillary rotation can be affected by many factors including

Table 3 - Data collected from selected articles showing alterations in sagittal skeletal angular measures (SNA e SNB); dental angular (IMPA) and linear (1-NA, 1-NB) measures.

	Movement		Incisor Movement	
Mask	Maxillary (SNA)	Mandibular (SNB)	Upper (1-NA)	Lower (1-NB; IMPA)
Delaire[2,7,8,42]			1-NA increase	1-NB Decrease
Grummons[21]	Anteroinferior movement	Clockwise rotation	4.1 mm mesialization of upper 1st molar	1-NB and IMPA Decrease
Petit[2,40,41,50] Turley[25,41] Baptista[3,16] Sky Hook[6] Nanda[34] Türbinger[33,40]	SNA increase	SNB decrease	3.4 mm overjet 1-NA increase	1-NB Decrease

Table 4 - Data collected from the selected articles showing the linear sagittal (AFAI) skeletal measurements and vertical angles (SN.GoGn, FMA).

Skeletal measurements	Linear sagittal	Vertical angles	
	AFAI	SN.GoGn	FMA
Delaire[2,7,8,42]	Considerable increase	Increase	
Grummons[21] Petit[2,40,41,50] Turley[25,41] Baptista[3,16]	Increase – Profile improvement	Increase - Profile improvement	
Sky Hook[6]	Increase	Increase: Discrete effect	
Nanda[34]	Increase: Discrete effect	Increase: Discrete effect	
Türbinger[33,40]	Increase	Increase	

the point where the force is activated, the direction of elastic traction and the patient's facial pattern.[50] Nanda used the molars due to the necessity of adapting the modified AEB to the tubes of these teeth, yet with force vectors passing through the center of the maxillary resistance to ensure movement of the maxilla with minimal rotation.[34] The point of application of the force on the maxilla varies according to the necessity of each case.[16] For upper arch traction, elastics originating from the upper first molars are used, while for other cases,[21] elastics are placed transversely from the bands on deciduous molars to the facial mask, protecting the corners of the mouth.

No uniformity in relation to the value of the angulation to the occlusal plane and force vector could be found, varying from 20º to 45º[2,7,8,25,33,34,40-42,50] (Tab 2). In some papers, only the following informations were given: "anteroinferior inclination"[3,6,16,21] or "force vector 15 mm above and parallel to the occlusal plane with the line of action through the center of maxillary resistance favoring anterior movement with minimal clockwise maxillary inclination".[34] In the encountered results, the force applied to each side of the maxilla varied between 230 gf to 285 gf/side, meanwhile authors[8,41] suggest using orthopedic forces to pull the maxilla with forces of 230 g to 285 g.[8] The suture anatomy and age of the patient have an important role in determining the magnitude of the force necessary for maxillary protraction, because, maxillary sutures such as the zygomatic-maxillary, pterigo-palatine and nasomaxillary sutures become mechanically interlaced and sinuous in their trajectories, with numerous areas of bone remodeling (apposition, absorption, synostosis), which slightly resembles the median palatine suture in younger individuals.[34]

When evaluating the effects between the same models among different authors[2,3,8,16,25,27,33,40,41,50] (Tab 2), there was no uniformity in relation to the amount of time of use per day, varying between 10 hours/day and 24 hours/day. Night time use is recommended due to the discomfort and appearance of the apparatus. In addition, and collaboration obtained in clinical practice is good if the minimal protocol of 8 to 10 hours is accepted (night time use).[6] In the same manner, when comparing different models,[2,3,6,7,8,16,21,25,33,34,40,41,42,50] there was no consistency in relation to the duration of the treatment varying from 6 to 31 months. The force is applied until positive overjet or Class I occlusion is obtained.[50] The device is monitored every 3 to 5 weeks, with force that is being increased being between 0.3 and 0.4 N on each side.[21]

In the Grummons model, without chin support, there was clockwise maxillary rotation, with increase in SNA, ANB and slight clockwise rotation of the maxillomandibular complex.[21] With the Nanda model, there was a 1 to 3 mm translation of the maxilla and remodeling of the B point, improving the profile.[34] There was distinct improvement in the sagittal maxillomandibular relation with alteration in the facial convexity, and medium increase of the ANB angle of 2.1º.[34] The use of expanders and quad-helix can be employed with extra-oral forces using the Batista device.[3] Even without external chin support, there was clockwise mandibular rotation due to lower molar anchorage, and the vector of maxillary traction promoted maxillary protraction with clockwise rotation in the anteroinferior direction.[3] Even varying the nomenclature among the authors, there was vestibular movement of the upper incisors, compensation of the Class III malocclusion with consequent increase of 1-NA in all models.[51] With the Grummons model there was vestibularization of the upper incisors with a 3.4 mm average increase of the overjet. This effect could be caused by the compression of the soft tissue in the chin region as a consequence of chin support (Tab 3).[50] In this model a posteroinferior biteplate was used with the plane inclined vestibularly stimulating anterior displacement of the maxilla and Hawley bow stimulating lingual inclination of the lower incisors.

In all models there was an increase in the AFAI, SN.GoGn and FMA angles, with consequent clockwise mandibular rotation. For the Grummons model, these results imply a better sagittal relation between the maxilla and mandible with a profile improvement. The AFAI increased due to facial growth.[25] The anterior positioning of the hooks and use of the Sky Hook device denote concern with vertical displacement, triggering milder vertical components.[6] Backward rotation of the mandible is similar to the results obtained in numerous previous studies investigating an assortment of modified facial masks, the main reason being the reduction of the SNB values and increase in SNGoGn.[14]

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The mandibular rotation could be due to the vertical maxillary movement and retraction force on the chin,[50] and eruption of the upper molars.[7] This rotation influences anterior overjet, the skeletal maxillomandibular relationship, the facial convexity and increase of the AFAI.[50] In the selected articles, it was observed that there was no relation in the aesthetic requirement in the perception by the patients, laypersons and professionals, since the facial mask could influence or interfere in the results of the treatments. The Sky Hook and Grummons models have less aesthetic compromise and vertical effects, being recommended for patients with increased AFAI. The Nanda model[34] occasioned minimal mandibular rotation, showing that predictable changes can be achieved regarding the maxillary advancement, with desired mandibular changes or absence of undesired alterations, since altering the point of application of the force on the mask or on the external curve of the facial arch, the vertical dimension could be controlled satisfactorily. This fact is especially important for Class III patients with long vertical dimension and excessive mandibular plane angle.[6]

CONCLUSIONS

Upon analyzing the literature related to the effects of reverse-pull of the maxilla in patients treated with eight different models of facial masks, it was considered that:

a) There was no uniformity in choice of the extra and intraoral anchorage types, direction and magnitude of elastic forces and time necessary for the treatment duration.
b) There were similarities in skeletal and dental measurements: anterior displacement of the maxillary complex (increase in SNA); anterior displacement of upper teeth (increase in 1-NA); lingual inclination of lower incisors (decrease in 1-NB); backward-downward rotation of the mandible (increase in AFAI, SN.GoGn and FMS; decrease in SNB), resulting in significant improvement in facial profile and establishment of positive overjet.

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Effect of rapid maxillary expansion on the dimension of the nasal cavity and on facial morphology assessed by acoustic rhinometry and rhinomanometry

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Objective: To assess the effects of rapid maxillary expansion on facial morphology and on nasal cavity dimensions of mouth breathing children by acoustic rhinometry and computed rhinomanometry.

Methods: Cohort; 29 mouth breathing children with posterior crossbite were evaluated. Orthodontic and otorhinolaryngologic documentation were performed at three different times, i.e., before expansion, immediately after and 90 days following expansion.

Results: The expansion was accompanied by an increase of the maxillary and nasal bone transversal width. However, there were no significant differences in relation to mucosal area of the nose. Acoustic rhinometry showed no difference in the minimal cross-sectional area at the level of the valve and inferior turbinate between the periods analyzed, although rhinomanometry showed a statistically significant reduction in nasal resistance right after expansion, but were similar to pre-treatment values 90 days after expansion.

Conclusion: The maxillary expansion increased the maxilla and nasal bony area, but was inefficient to increase the nasal mucosal area, and may lessen the nasal resistance, although there was no difference in nasal geometry. Significance: Nasal bony expansion is followed by a mucosal compensation.

Keywords: Palatal expansion technique. Mouth breathing. Malocclusion. Cephalometry.

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How to cite this article: Itikawa CE, Valera FCP, Matsumoto MAN, Lima WTA. Effect of rapid maxillary expansion on the dimension of the nasal cavity and on facial morphology assessed by acoustic rhinometry and rhinomanometry. Dental Press J Orthod. 2012 July-Aug;17(4):129-33.

Submitted: March 03, 2010 - **Revised and accepted:** June 20, 2011

» The authors report no commercial, proprietary or financial interest in the products or companies described in this article.

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INTRODUCTION

Mouth breathing alters facial muscles and bones.[16] Mouth breathing children present maxillary atresia and dentoalveolar changes associated to hypotonia in tongue, lips and cheeks. These changes, in turn, lead to: 1) compression of the alveolar processes,[17] 2) retrusion of the nasal cavity and of paranasal sinuses, 3) increase of anterior facial height and of palatal and mandible planes,[15] and 4) maxillary and mandible retrusion.

Rapid maxillary expansion is one of the most frequently used techniques in orthodontics to correct the atresia in superior dental arch and palate, as well as posterior crossbite with normal inclination of the teeth.[14] Its success is mostly affected by the age of activation (best between 7 and 10 years of age),[11] and the breathing pattern of the patient.

The objectives of the present study were to determine the morphological pattern of the face and the nasal area , and resistance on mouth breathing children with mixed dentition before and after rapid maxillary expansion by acoustic rhinometry and computed rhinomanometry.

MATERIAL AND METHODS

Twenty-nine mouth breathing patients of both genders, with ages ranging from 7 to 10 years, were studied. The patients were in the mixed dentition phase and had uni- or bilateral posterior crossbite including the deciduous canines and molars and the first permanent molars.

The children were evaluated and diagnosed as mouth breathers by the same otorhinolaryngologist, at the Service of Pediatric Rhinosinusology, Division of Otorhinolaryngology, School of Medicine of Ribeirão Preto, USP.

After the first evaluation, all the children underwent acoustic rhinometry (ARM) and rhinomanometry (RMM). For these exams, the patients remained in an acoustic-treated room, with a constant temperature of 25º C for 15 minutes. Topical vasoconstrictor was not administered previously to these exams, since the objective of these studies was to observe mucosal changes to the bone expansion. SR2000 equipment, Rhinometrics, (Denmark) with nasal adaptors were used to analyze the results.[18]

For ARM, the minimal cross-sectional area (MCA) 1 (corresponding to nasal valve) and 2 (corresponding to inferior turbinate) were examined for each nostril. In RMM, the resistance during both inspiration and expiration was verified for each nostril.

Complete orthodontic documentation (lateral and posteroanterior cephalometric radiographs, study models, extraoral front and profile photographs, and intraoral photographs) was also obtained.

The following measurements were made in the posteroanterior radiographs (Fig 1): NC-NC, which corresponds to the nasal width,[10,12] JL-JR, which corresponds to the maxillary width,[10,12] JL-ZAgL, which corresponds to the maxillary-mandibular width left side, and JR-ZAgR which corresponds to the maxillary-mandibular width right side.

After analysis of the initial documentation and planning of orthodontic treatment, tooth- and mucosa-supported orthodontic braces - Haas disjunctor - were placed to correct uni- or bilateral crossbite. The braces were installed and activated according to the principles presented by Haas.[4] Briefly, patients were instructed to activate their

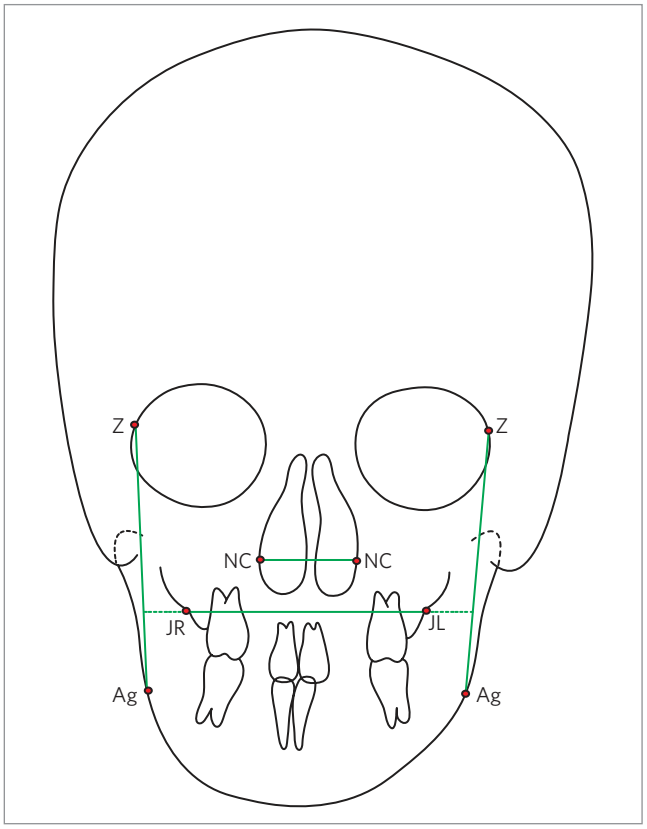


Figure 1 - Cephalometric tracing of the posteroanterior radiography.

RME twice daily until posterior crossbite was corrected (observed when superior first molars were naturally opposed to inferior ones). After retention period (90 days), Haas disjunctor was replaced to a superior functional appliance, stabilizing the occlusion and peri-oral muscles.

The RMM, ARM and cephalometric exams were performed before (T_1), immediately after (T_2) and 90 days after (T_3) rapid maxillary treatment.

The Hotteling T_2 test was used to compare the mean values of each variable at the three time points in the study.

The present study was approved by the Research Ethics Committee of the Dental School of Ribeirão Preto, University of São Paulo (process nº 2003.1.25.58.0), and all the patients' parents gave written informed consent to participate in the study.

RESULTS

The results in ARM and RMM are presented in Tables 1, 2 and 3. There was a reduction in nasal resistance immediately after nasal expansion, which returned to pretreatment levels 90 days after RME. There was no statistical difference between times for MCA 1 and 2.

The results of each cephalometric variable obtained at the three time points in the study are presented in Tables 4 and 5. There was a significant increase in lateral width of nasal bone (NC-NC), maxilla (JL-JR), JL-ZAgL, and JR-ZAgR. Mean NC-NC, JL-JR, JL-ZAgL and JR-ZAgR differed significantly between T_1 and T_2 and between T_1 and T_3, but not between T_2 and T_3.

DISCUSSION

Posterior crossbite is considered to be one of the most common malocclusions[3] and its prevalence is approximately 8% in the deciduous dentition[8] and 27%[9] in mixed dentition. This condition tends to get worse during facial growth, and rapid maxillary expansion should be instituted as early as possible.

In the present study, mouth breathing children were selected after been diagnosed by an otorhinolaryngologist after the clinical examination, including nasoendoscopy. All of them also presented uni- or bilateral posterior crossbite associated to palatal atresia. The use of the Haas disjunctor was indicated with the specific objective of promoting orthopedic expansion of the maxilla in order to correct the posterior crossbite. Weekly monitoring of the activators was done during this procedure in order to avoid excessive expansion.

Frontal radiographs revealed an skeletal increase in the lateral dimension of the nasal cavity and maxillary bone after palatal disjunction, and this increase was stable 90 days after correction. These results agree with those reported by other authors.[10,2,6] The bone corrections are more easily achieved if treatment is initiated before complete

Table 1 - Mean values and standard deviations of acoustic MCA 1 and 2 before orthodontic treatment, immediately after and 90 days after treatment, calculated F value and value of the Hotelling T_2 test for equality of the means.

Measure	Time	Mean	Standard deviation	$F_{2,27}$	Test value
MCA 1	T_1	0.987	0.191	0.596	0.558
	T_2	1.006	0.182		
	T_3	0.973	0.196		
MCA 2	T_1	0.732	0.223	1.025	0.372
	T_2	0.780	0.200		
	T_3	0.763	0.248		

Table 2 - Mean values and standard deviations of resistance during inspiration and expiration before orthodontic treatment, immediately after and 90 days after treatment, calculated F value and value of the Hotelling T^2 test for equality of the means.

Measure	Time	Mean	Standard deviation	$F_{2,27}$	Test value
Inspiration	T_1	3.368	1.226	11.570	< 0.001
	T_2	2.859	1.460		
	T_3	2.231	0.763		
Expiration	T_1	2.675	0.943	10.064	0.000
	T_2	2.271	1.365		
	T_3	1.828	0.599		

Table 3 - Mean values and standard deviations of differences between respiratory measures in two different moments, and Bonferroni's value for multiple comparisons.

Measure	Time	Mean of Differences	Standard error	Test value
Inspiration	$T_1 - T_2$	-0.509	0.368	0.535
	$T_1 - T_3$*	-1.136	0.261	< 0.001
	$T_2 - T_3$	-0.628	0.266	0.076
Expiration	$T_1 - T_2$	-0.404	0.310	0.612
	$T_1 - T_3$*	-0.846	0.201	0.001
	$T_2 - T_3$	-0.442	0.239	0.225

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Table 4 - Linear orthodontic measurements (mean and standard deviation) made before, immediately after and 90 days after rapid maxillary expansion, calculated F value and value of the Hotelling T_2 statistical test for equality of the means.

Measure	Period	Mean	Standard deviation	$F_{2,27}$	Test value
NC-NC	T_1	24.91	1.88	47.048	< 0.001
	T_2	26.21	1.68		
	T_3	26.38	1.93		
JL-JR	T_1	58.86	2.71	48.190	< 0.001
	T_2	62.38	2.53		
	T_3	62.10	2.65		
JL-ZAgL	T_1	11.24	1.77	13.90	< 0.003
	T_2	10.28	1.56		
	T_3	10.17	1.53		
JR-ZAgR	T_1	11.93	1.73	13.90	< 0.003
	T_2	11.07	1.79		
	T_3	10.75	1.90		

Table 5 - Mean values and standard deviations of differences between linear orthodontic measurements between two different moments and Bonferroni's value for multiple comparisons.

Measure	Time	Mean of differences	Standard error	Test value
NC-NC	$T_1 - T_2$*	1.293	0.218	< 0.001
	$T_1 - T_3$*	1.466	0.149	< 0.001
	$T_2 - T_3$	0.172	0.165	0.916
JL-JR	$T_1 - T_2$*	3.517	0.370	< 0.001
	$T_1 - T_3$*	3.241	0.339	< 0.001
	$T_2 - T_3$	-0.276	0.216	0.635
JL-ZAgL	$T_1 - T_2$*	-0.860	0.160	< 0.005
	$T_1 - T_3$*	-1.170	0.160	< 0.039
	$T_2 - T_3$	-0.310	0.080	0.999
JR-ZAgR	$T_1 - T_2$*	-0.970	0.160	< 0.029
	$T_1 - T_3$*	-1.070	0.170	< 0.000
	$T_2 - T_3$	-1.030	0.050	0.351

* Significant difference ($p < 0.05$).

permanent dental eruption, when calcification of the craniofacial sutures is not achieved, and maxillary expansion is consequently easier.

The importance of respiratory function for facial and occlusal development has become clear in Orthodontics.[7] For this reason, quantifying methods for nasal patency are important to better understand its influence on orthodontic measures.

The radiological results showed that rapid maxillary expansion increased the bony nasal cavity (confirmed by the cephalometric measures NC-NC), and on maxilla, evaluating by JL-ZAgL, and JR-ZAgR. We could observe that, although there was a significant increase in bony width of nasal cavity and maxilla and slight decrease of nasal resistance, there was not an increase in mucosal nasal cavity.

Bicakci et al[1] also evaluated the effects of rapid maxillary expansion on nasal cavity by acoustic rhinometry. Instead of our results, they observed an increase in MCA after rapid maxillary expansion. In the present study we did not detect significant differences in minimal cross-sectional area, neither in the region of the nasal valve nor in the inferior turbinate at the three time points studied.

Our results suggest that there is an increase of transverse width of maxilla and nasal cavity, which leads to lateralization of inferior turbinates. However, differently from other studies, this bony lateralization induced a mucosal compensation, and the improvement in nasal mucosa was not so marked as bony expansion. We believe that is "compensation" could be due to edema or hypertrophy of inferior turbinates, for example.

Hartgerink et al[5] evaluated a sample of 38 patients aged 7.5 to 22.3 years treated with a Haas disjunctor or an occlusal splint by rhinomanometry at the same time points as used in the present study, but after nasal decongestion. Hershey et al[6] studied 17 patients aged 11 to 14 years treated with a Haas disjunctor, and Timms[13] evaluated 26 patients aged 10 to 19, with and without the use of a nasal decongestion and with rhinomanometry before and after expansion in both series. All investigators detected a reduction in nasal resistance after expansion.

In agreement with these authors, the results of the present study showed that mean nasal resistance during inspiration (inspiration at T_3 = 2.231 l m/cm H_2O) and expiration (expiration at T_3 = 1.828 l m/cm H_2O) were significantly lower after treatment than before treatment (inspiration at T_1 = 3.368 l m/cm H_2O and expiration at T_1 = 2.675 l m/cm H_2O).

Our results may differ from others because we opted not to use topical vasoconstrictor while performing the RMM and ARM. As we had already the bony dimension through cephalometry, and we wanted to observe the mucosal response to this bony expansion, we opted not to use vasoconstrictor.

Orthodontists indicate and perform expansion in order to correct uni- or bilateral crossbite, believing that it also relieves the respiratory difficulties in these patients. However, the results of the present study do not support that rapid maxillary expansion could be employed merely in order to improve nasal function of individuals with respiratory difficulties.

The present study detected an increase in the bony dimension of the nasal cavity and a significant decrease in nasal resistance, although there was no significant difference in MCA on nasal valve or inferior turbinate. Even though, the results of the present study do not support the indication of rapid maxillary expansion merely in order to provide benefits for the nasal function of individuals with respiratory difficulties, since mucosal benefits were much slighter than bony ones.

CONCLUSION

On the basis of the present results, it was possible to conclude that there was a significant increase in nasal and maxillary transversal bony width. These bony changes were followed by discrete alterations in nasal resistance, and no difference in nasal volume was detected, showing that the mucosal changes are slighter that bony ones when maxillary expansion is employed.

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Mini-implant and Nance button for initial retraction of maxillary canines: A prospective study in cast models

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Objective: Bone anchorage is a key factor for the successful management of some malocclusions for it allows the application of continuous forces, decreases treatment time and is independent from patient compliance.

Methods: The goal of this work was to establish a dental model comparison in order to measure the anchorage loss after the initial retraction of upper canines between the two groups. Group A used mini-implants and Group B used Nance Button. All patients had two models cast (M1 and M2). The first models were taken on baseline (M1) and the other models were taken after canine retraction (M2).

Results: All measurements were pooled and submitted to statistical analysis. In order to verify the inter-examiner systematic error a paired t-test was performed. Dahlberg's formula was used to estimate the casual error. For comparison purposes between Before and After stages, a paired t-test was done. For the comparison between mini-implant and Nance Button groups, a Student t-test was applied. All tests adopted a 5% ($p<0,05$) significance level.

Conclusion: No statistically significant difference was observed between the two groups when measurements and comparisons to assess molar anchorage loss after canine initial retraction were performed. Two different anchorage systems were applied on dental models (mini-implants and Nance's button) for each group.

Keywords: Orthodontic anchorage procedures. Dental casting technique. Orthodontics.

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How to cite this article: Arantes FM, Kina J, Gonçalves MJB, Gurgel JA, Silva Filho OG, Santos ECA. Mini-implant and Nance button for initial retraction of maxillary canines: A prospective study in cast models. Dental Press J Orthod. 2012 July-Aug;17(4):134-9.

Submitted: February 12, 2010 - **Revised and accepted:** September 20, 2011

» The authors report no commercial, proprietary or financial interest in the products or companies described in this article.

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

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INTRODUCTION

Anchorage is a key factor for a successful orthodontic approach.[19] Although orthodontic treatments have been quite successful, some limitations should be observed towards certain movements and much has been done to accomplish an effective patient cooperation.[5] Over the last two decades mini-implants have been introduced in orthodontic clinical practice with the purpose of providing anchorage and have shown to be quite a promising option.[3,4,16,17] The use of a stable anchorage eliminates undesirable movements upon anchoring teeth and replaces traditional procedures such as the headgear, what allows for continuous force application leading to a shorter treatment time.[1,14]

The intensity of the load may vary from one type of movement to the other. Regarding retraction movements, the load applied differs from initial canine retraction to anterior retraction. For initial retraction, the load ranges from 50g[5,11] to 100g,[5,20] whilst for anterior retraction it ranges from 150 to 200g,[5] allowing for even higher load intensities such as 200g and 300g[5,9,11,12] with good results and without any jeopardise to the root structure or the periodontium. For molar mesialization movements towards the gaps of prematurely lost teeth, Roberts[5,15] suggests the use of 408g for moving second and third molars.

Mini-implants may be self-piercing[6] or self-tapping (with and without previous perforation procedure, respectively). Some authors[7,18] state that the self piercing mini-implants are more traumatic since this procedure induces physical pressure and micro fractures in the surrounding bone structure, possibly leading to periosteal or endosteal injury. However, other professionals argue that the self-tapping mini-implant system causes larger bone trauma due to the frictional heat created by the threads during the perforation previously performed.[18]

With regards to the time for load application there is no consensus. Many periods have been studied, varying from immediately after to 2, 4 or 6 weeks later,[5,10,12] and the implant loss, in none of the works, was ever related to the waiting interval.

In an attempt to be less reliant on patient cooperation and to be able to achieve new anchorage solutions in orthodontic treatments, mini-implants are recommended for adult patients in need of maximum anchorage (intrusion, extrusion, retraction and protraction) who are reluctant to use extra-oral braces as well as in cases where the orthodontic anchorage cannot be accomplished due to tooth losses.

For the reasons above listed and for the indiscriminate clinical application of mini-implants the related anchorage loss there came the interest for this subject. The goal of this work was to use dental models to establish a comparison, between two groups, of the upper first molars anchorage loss after upper canines initial retraction. While Group A used mini-implants, Group B used the conventional intra-oral anchorage technique. The null hypothesis to be tested is that both anchorage systems present similar results.

MATERIAL AND METHODS

In this experiment 18 patients were selected, average age 15 years old, randomly divided between two groups, with 9 subjects each (A e B), out of the screening for orthodontic treatment at Araçatuba School of Dentistry - UNESP. The inclusion criteria for the research were:

a) Patients with a balanced facial pattern[15,16]
b) Patients in the post growth spurt phase
c) Patients presenting upper anterior crowding, demanding upper and lower pre-molars extractions (Fig 1).

Orthodontic therapy for patients with upper anterior crowding from Group A was carried out by the use of self-tapping 1,6 x 10mm titanium mini-implants from SIN (Sistema de Implante, São Paulo, Brazil).



Figure 1 - Intraoral view of a patient with upper anterior crowding.

Squeff et al,[18] after determining topography, archetype and torque test of some SIN mini-implants, stated that all tested mini-implants were adequate for clinical application as an adjunct to orthodontic anchorage.

Implants were inserted both sides into the upper alveolar bone, between the second pre-molar and first molar, over attached gingiva. In order to prevent root lesions, they were inserted in the interseptal areas of these teeth, guided by the periapical radiographs, taken under the parallelism technique. After implant insertion, the first pre-molars were extracted, with an immediate onset of 150cN load applied over the canines. In the lower arch, the lingual arch was used as anchorage. Alignment and levelling were performed with Edgewise fixed appliance, according to Capelozza prescription, Standard I, (Abzil 3M, São José do Rio Preto, Brazil).

Group B received orthodontic treatment using Nance Button as the anchorage system for the upper arch and Nance lingual arch for the lower teeth, both manufactured using a 0.9 mm wire (Morelli). The anchorage systems were first incorporated followed by Edgewise appliance fixation, according to Capelozza prescription, Standard I (Abzil 3M), and subsequent extraction of the first pre-molars. Initial canine retraction under 150cN load per side was immediately started.

All patients had two impressions taken: M1 model (taken at baseline) and M2 model (taken after the initial canine retraction). This initial canine retraction phase was chosen due to the great anchorage loss that usually takes place during this treatment stage[4] and also for the clinically satisfactory incisors alignment. This work had no aim to assess anterior retraction, since during that treatment stage some anchorage loss was needed concomitantly to the group retraction

Plaster casts were obtained after an impression was taken with Kromopan alginate, batch number 0155300130.103 514 (Lascod SpA Florence Italy) and water, under a 1/1 proportion. Impressions were then poured with Durone V stone, batch 539589 (Dentsply Indústria e Comércio Ltda Petrópolis, RJ Brazil) and water under the proportion of 19mm of water for each 100g of plaster, in order to reproduce the dental structures as precisely as possible.

Aiming optimize the measurement of the dental models, which are tri-dimensional by nature, all upper models underwent a photographic scanning with an HP scanner (Scanjet G4050 China), being transferred to a two-dimensional and flat image. No models needed to be cut or trimmed since only the occlusal surface touched the scanner avoiding undesired tilting.

Both upper models (baseline and post canine initial retraction) from each patient were scanned together in order to avoid possible dimensional changes due to different scanning process. Moreover, models from each patient were scanned one at a time (Fig 2).

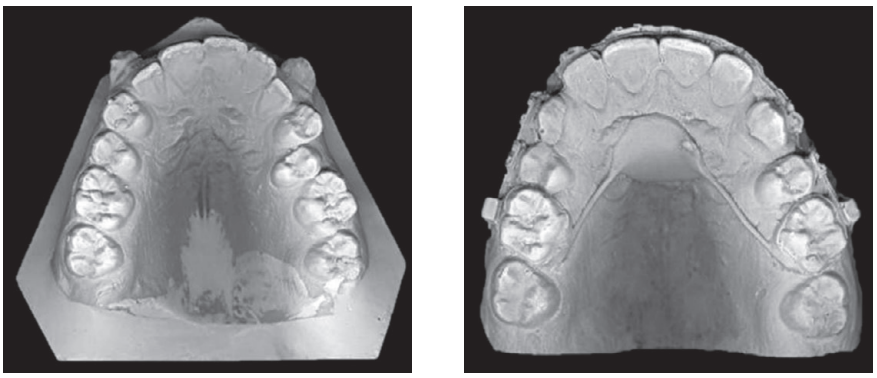


Figure 2 - Upper models (baseline and post canine initial retraction) were scanned separately for each patient.

The images obtained from the scanned models were transferred in the format of a Microsoft Office PowerPoint 2003 file to achieve better organization and standardization of the image selection process. Each patient was illustrated by two upper model images (baseline and post canine initial retraction), which were cut out in a standardized size, without dimensional alterations. Subsequently, this file was saved as a JPEG image and transferred to an AutoCad 2007 Autodesk software.

Measurements were performed based on the following reference points: point P, located at the centre of the incisive papillae, from which a line was drawn along the median palatal raphe; two other points, Cesq and Cdir, located at the centre of the mesiobuccal cusp of each permanent upper first molar, right and left sides, respectively. A line was traced from each of these points, perpendicularly to the median palatal raphe line, crossing it in two distinct locations, generating two other points: Cesq' (representing the intersection between the line drawn from the palatal raphe and Cesq point) and intersection point Cdir' (between the palatal raphe and the line stemming from Cdir point) (Fig 3).

The distances between the points Cesq' to P, and points Cdir' to P, crossing the median palatal raphe line are the measurements compared in both sides between the images of the models obtained at baseline and after the canine initial retraction. Therefore, these measurements represent the position of the permanent upper first molar on both left and right sides, relative to the incisive papilla, at baseline and post canine initial retraction stages. As these distances decrease, after canine initial retraction, it indicates the amount of mesialization of the permanent upper first molar on each side (anchorage loss).

All measurements were completed and submitted to statistic analysis. In order to verify the intra--examiner systematic error a paired t test was performed. For the casual error determination, Dahlberg's (Houston, 1983) formula was utilized.

d = difference between the 1st and 2nd measurements
n = number of repetitions

The results of the systematic error, measured by the paired t test and the casual error assessments are displayed on Table 1. Data were described according to the average and standard deviation shown on tables (Tables 2, 3, 4). In order to compare Before and After stages a paired t test was used. In order to compare Mini-screw and Nance Button groups a student t test was applied for independent measurements. All tests considered the 5% significance level ($p<0,05$). All statistic calculations were performed by the 5.1 Statistics for Windows software (StatSoft Inc, Tulsa, USA).

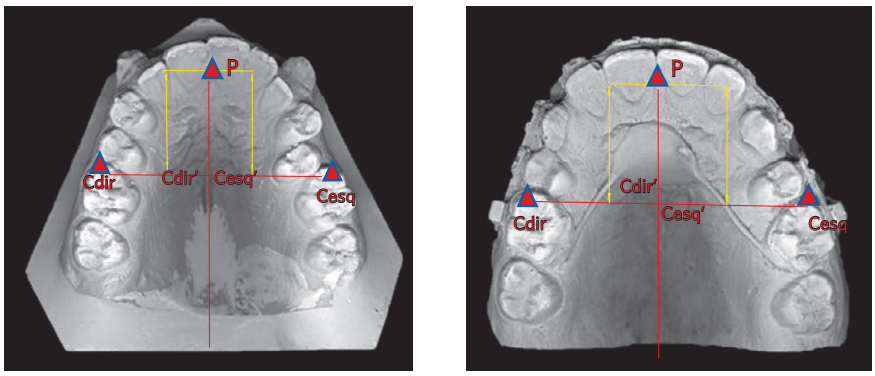


Figure 3 - Upper models (baseline and intermediate) with lines and points traced.

Table 1 - Average, standard deviation for both measurements, paired t test, and Dahlberg's systematic and casual errors. Right Side (distance between the centre of the mesiobuccal cusp of the upper permanent right first molar to point P); Left Side (distance between the centre of the mesiobuccal cusp of the left permanent upper first molar to point P).

Measure	First measurement		Second measurement		t	p	Error
	Mean	SD	Mean	SD			
Right side	55.57	7.13	55.08	6.86	1.041	0.325 ns	1.07
Left side	56.76	6.37	57.59	6.62	1.358	0.207 ns	1.43

ns: no statistically significant difference.

Table 2 - Average, standard deviation and comparison between Before and After measurements obtained from the models for the mini-screw group. Right Side (distance between the centre of the mesiobuccal cusp of the right permanent upper first molar to point P). Left Side (distance between the centre of the mesiobuccal cusp of the left permanent upper first molar to point P).

Measure	Beggining		After		Difference	t	p
	Mean	SD	Mean	SD	Mean		
Right side	53.06	8.29	50.41	5.86	-2.65	1.684	0.131 ns
Left side	52.96	5.70	51.06	7.21	-1.90	1.080	0.312 ns

ns: no statistically significant difference.

Table 3 - Average, standard deviation and comparison between Before and After measurements obtained from the models for the Nance Button group. Right Side (distance between the centre of the mesiobuccal cusp of the right permanent upper first molar to point P). Left Side (distance between the centre of the mesiobuccal cusp of the left permanent upper first molar to point P).

Measure	Beginning		After		Difference	t	p
	Mean	SD	Mean	SD	Mean		
Right side	53.01	7.18	50.16	7.05	-2.85	3.555	0.007 *
Left side	53.60	7.46	50.87	10.17	-2.73	1.576	0.154 ns

ns: no statistically significant difference *statistically significant difference ($p < 0.05$).

Table 4 - Average and standard deviation of the variations between Before and After, and comparison between mini-implant and Nance Button groups. Right Side (distance between the centre of the mesiobuccal cusp of the right permanent upper first molar to point P). Left Side (distance between the centre of the mesiobuccal cusp of the left permanent upper first molar to point P).

Measure	Mini implant		Lingual button		Difference	t	p
	Mean	SD	Mean	SD	Mean		
Right side	-2.65	4.73	-2.85	2.41	0.20	0.109	0.914 ns
Left side	-1.90	5.29	-2.73	5.19	0.83	0.333	0.743 ns

ns: no statistically significant difference.

RESULTS

Results are shown on tables 1 - 4.

DISCUSSION

Studies based on mini-screws positioned between the roots of second pre-molars and first molars have proved to be successful for mass retraction of the anterior segment as well as during canine initial retraction.[19,20]

The aim of this paper was to assess the anchorage loss of permanent upper first molars after canine initial retraction between two different anchorage methods (Nance Button and mini-screws).

The choice for assessing standardized stone dental models is justified by the existence of specific softwares capable of estimating molars anchorage loss. Canine initial retraction is an ordinary procedure within the orthodontic treatment. Many systems (appliances) are used to retract canines during space closure, which depends on many factors: type of system used, load applied, technique and periodontal condition.[20]

In this study, for Group A, mini-screws were inserted between the roots of permanent upper second pre-molars and first molars. Group B Nance Button was employed as an anchorage system.

The results revealed an average anchorage loss of 2,85 mm on the right side and 2.73 mm on the left side for the group with Nance button, even though the left side did not present any statistically significant difference (Table 3). These results were expected since load application is performed directly over the molars, confirming thus the null hypothesis.

It was also possible to observe by that even when bone anchorage is used, anchorage loss was detected on the upper molars for the mini-screw group (Table 2). These results demonstrate that bone anchorage cannot be ensured, since the mechanics, the intensity and control of the loads applied are still very relevant factors to be considered.[20] One hypothesis to explain the anchorage loss in the mini-screw group can be possible attributed to the levelling and alignment stage, since the friction between the wire and the molar tubes might have caused the molars to rotate, as no stabilization procedure was ever done. At the end of the canine retraction molars were assessed but no conclusion was drown whether the molars had gone through rotation or tilting, as it would usually happen in any orthodontic movement.

Table 4 shows no statistically significant difference between the two groups, mini-screw and Nance button), what doesn't necessarily mean there are no differences between, but rather the absence of evidence that could support that difference. Clinically, it could be observed that there was a higher anchorage loss in the group wearing Nance Button and that the interval for canine initial retraction was also longer.

Eighteen patients is quite a shy value for statistic analysis, although it could be considered quite a good number for a clinically based work. In addition, other scientific papers published used much smaller samples or even a single clinical case.

According to the present study, mini-screws cannot be considered as an absolute anchorage method. Nonetheless, studies that advocate it as the ultimate anchorage option, are actually based on clinical reports, what hinders the possibility of taking a conclusion, in other words, there are no scientific evidences. Such an argument encourages the development of standardised methodology studies. Therefore, studies that verify the effectiveness of the anchorage and the biological cost of the mini-screws are to be further developed.

CONCLUSION

After measuring and comparing models for the assessment of molars anchorage loss after canine initial retraction by means of two systems (mini-implants and Nance button) no statistically significant difference could be observed between the two groups.

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Determination of the structural characteristics in youngsters from Ceará with Class II, division 1 malocclusion

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Objective: To determine the structural characteristics of Caucasian youths from Ceará State, Northeastern Brazil, presenting with Class II, Division 1 malocclusion and to investigate whether there is gender dimorphism based on the cephalometric variables assessed.

Methods: By means of lateral cephalograms, it was possible to determine the cephalometric characteristics of Class II, Division 1 malocclusion in a sample of 50 Caucasian youths from Ceará State, Brazil, of both genders (25 male and 25 female), aged between 9 and 14 years, who had not received previous orthodontic treatment. Sixteen cephalometric measures were evaluated and a comparison was made between the experimental group (Class II) and the control group (Class I), a sample comprising 50 Caucasian children from the Brazilian State of Ceará, of both genders (22 male and 28 female), aged 9 to 13 years, obtained from research conducted at the Study Center of the Federal University of Ceará (UCCB), Department of Orthodontics.

Conclusions: Overall, the maxilla exhibited adequate positioning. The mandible showed a clear predominance of retrusion and dimensional changes in the sagittal direction. The facial vertical dimensions were increased. The maxillary incisors were well-positioned in their apical bases and with slight lingual inclination. The mandibular incisors were labially inclined and protruded. The study identified the presence of gender dimorphism in the following measures: P-Nperp, Co-A, Wits and ALFH.

Keywords: Angle Class II malocclusion. Cranial circumference. Orthodontics.

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How to cite this article: Castelo KMS, Bramante FS. Determination of the structural characteristics in youngsters from Ceará with Class II, division 1 malocclusion. Dental Press J Orthod. 2012 July-Aug;17(4):140-7.

Submitted: April 8, de 2010 - **Revised and accepted**: September 18, 2011

» The authors report no commercial, proprietary or financial interest in the products or companies described in this article.

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INTRODUCTION

With the purpose of establishing scientific standards for different racial groups, dentofacial behavior studies have been conducted by researchers in various ethnic groups. Current cephalometric standards do not apply to all individuals given the wide range of racial and miscigenation characteristics.[2]

Comparative cephalometric evaluations showed indeed the existence of differences in craniofacial morphology between different racial groups.[15] The ethnic background of Ceará State`s population comprise a miscegenation of Portuguese and Indians (indigenous population), resulting in a facial pattern that differs from other populations. This population can be identified as a group with facial and skeletal features that represent a particular morphological pattern: the brachycephalic.[10]

In this context and in light of the proven variability, research was carried out to determine the skeletal and dental characteristics of Class II, Division 1 malocclusion, present in 22.3% of Ceará youths.[10] Knowledge of this population characteristics is of utmost importance, since, due to geographic and economic difficulties, a wide emigration process occurs from that region to more developed and therefore more attractive ones, not only inside Brazil but also to other countries. Evaluation of the cephalometric characteristics of Class II, Division 1 malocclusion was performed in a sample of 50 Caucasian Ceará youths, which ultimately provided further information about the dentoskeletal patterns of this racial group.

MATERIAL AND METHODS

The sample for the experimental group consisted of 50 lateral cephalograms of Caucasian Ceará youths of both genders (25 male and 25 female) aged between 9 and 14 years presenting with Class II, Division 1 malocclusion, originated from a private file comprising 5,000 orthodontic records.

The following selection criteria were used for inclusion of individuals in the experimental group: dental casts displaying increased overjet, ½ Class II, ¾ Class II and full Class II molar relationship, ANB angle of 4.5° or greater with no history of previous orthodontic treatment and radiographs taken using the same equipment.

The control group consisted of 50 lateral cephalograms of Ceará youths (22 male and 28 female) aged between 9 and 13 years, all with normal occlusion (molar and canine Class I), displaying facial harmony in frontal and lateral views, normal overbite, dental irregularities, if present, did not surpass 3 mm, overjet of 3 mm or lower, and no previous orthodontic treatment.

After selecting the lateral cephalometric radiographs the images were scanned. Thereafter, these images were imported into the Cef-X software (CDT software, version 2.1.24). The patients were registered and points of interest marked following the guidelines provided by the software.

The anatomical points (landmarks) were marked, resulting in the angular and linear cephalometric measures of interest, following the specifications of Downs,[5] Riedel,[15] Steiner and Riedel,[24] Jacobson[6] and McNamara Jr.[11] The lines and planes that compose the skeletal and dental cephalometric variables used in the study are shown in Figures 1 and 2. The linear and angular measures used for the control and experimental groups were: SNA, SNB, ANB, SNGoGn, 1.NA, 1-NA, 1.NB, 1-NB, Co-A, Co-Gn, ALFH, DMM, A-Nperp, P-Nperp, Wits and HF.PM. The values of the experimental group were compared to the control group's values and the statistical test applied.

Method error

In order to determine the results` reliability a second measurement was performed on all cephalometric radiographs after a 30 days interval by the same subject. The systematic and random errors (Dahlberg and *t* test respectively) were applied to each cephalometric measure.

Statistical Analysis

After registering the cephalometric measurements a normality test (Shapiro-Wilk) was performed. Since variables ANB and ALFH had a *p* value lower than 0.05, they were analyzed by the nonparametric Wilcoxon test. To test compatibility between groups regarding age as well as the mean and standard deviation values of the cephalometric variables, Student's *t* test was applied. A significance level of $p < 0.05$ was adopted. To check for the existence of gender dimorphism Student's independent *t* test was applied.

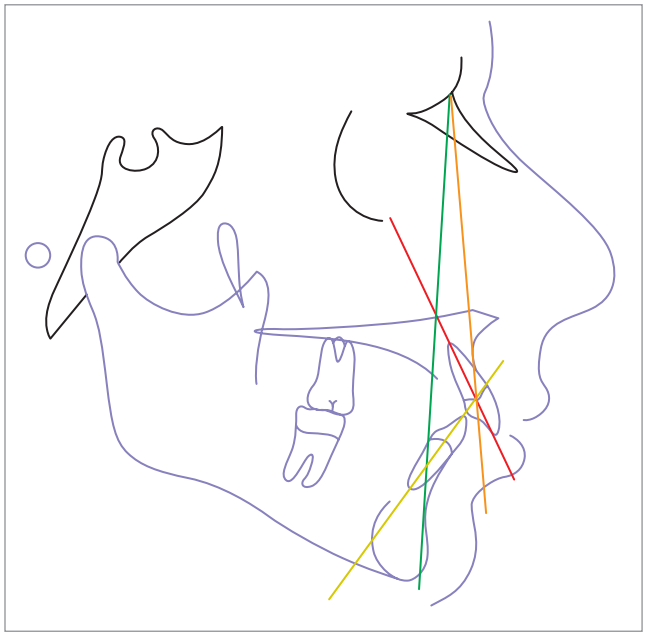


Figure 1 - Skeletal cephalometric variables, according to Dows, Riedel , Steiner and Riedel, Jacobson, McNamara Jr.

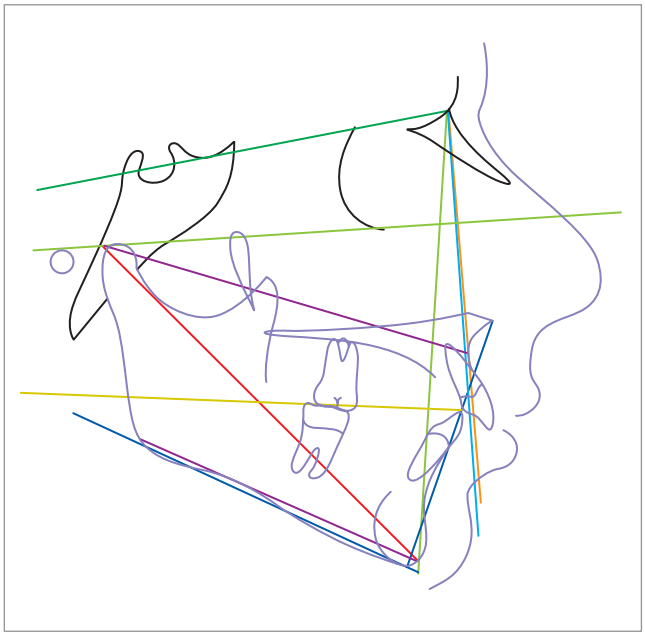


Figure 2 - Dental cephalometric variables according to Steiner and, also, Steiner and Riedel.

RESULTS

The data in Table 1 show normal distribution for 14 of the 16 measures assessed. According to the Wilcoxon data in Table 2, ANB showed no significant pre/post difference ($p > 0.05$). Variable ALFH showed significant pre/post difference ($p < 0.05$). The data presented in Table 3 show the two measurements taken with a 30 day interval, displaying the means and standard deviations of the paired *t* test and the random error. Among the 16 variables studied, only one exhibited systematic error (bias): ALFH.

Comparison between genders showed that four measures had statistically significant differences (Tab 4). Table 5 presents a comparison between the experimental and control groups.

DISCUSSION

In assessing gender dimorphism in the experimental group only four measures displayed statistically significant differences. All differences between variables were found in linear measures: Co-A, P-Nperp, Wits and ALFH. These results are consistent with a study which found that only linear measurements show significant differences between genders in Class II, Division 1 malocclusions.[5] Silva Filho et al[23] found that the behavior of angular cephalometric measures in Class II, Division 1, Pattern II malocclusion is independent of the gender variable.

The sagittal position of the maxilla (SNA) displayed similarity between the experimental and the control groups, revealing to be well positioned in relation to the skull base. This finding is confirmed by most published works.[1,4,9,13,16,20,22] Some researchers support the idea that changes in the respiratory function may lead the soft tissues of the face to increase in length. These tissues can inhibit the forward development of the nasomaxillary complex, maintaining the maxilla in a good position.[24] Measured linearly, the maxilla was found to be in a protruded position. This mismatch between the SNA angle and A-Nperp values can be explained by the difficulty in locating some landmarks related to the Frankfurt plane, such as Condylion and Orbitale. Potential changes in the inclination of the aforesaid plane, resulting from the above mentioned difficulties would imply changes in the A-Nperp measurement.[22]

Analysis of mandiblar position assessed by SNB angle showed that the mandibular retrusion in

Table 1 - Shapiro–Wilk test.

VARIABLES	W	P
Age 1	0.96	0.24
Age 2	0.96	0.24
CEPHALOMETRICS		
SNA 1	0.98	0.72
SNA 2	0.98	0.77
SNB 1	0.98	0.90
SNB 2	0.98	0.86
ANB 1	0.88	0.00
ANB2	0.88	0.00
A-Nperp 1	0.98	0.77
A-Nperp 2	0.97	0.63
P-Nperp 1	0.95	0.10
P-Nperp 2	0.94	0.05
Co-A 1	0.98	0.91
Co-A 2	0.98	0.92
Co-Gn 1	0.97	0.65
Co-Gn 2	0.97	0.49
DMM 1	0.97	0.70
DMM 2	0.97	0.61
SNGoGn 1	0.97	0.50
SNGoGn 2	0.95	0.19
AFAI 1	0.94	0.04
AFAI 2	0.96	0.02
1-NA 1	0.97	0.44
1-NA 2	0.97	0.44
1.NA 1	0.98	0.84
1.NA 2	0.98	0.92
1-NB 1	0.94	0.06
1-NB 2	0.95	0.07
1.NB 1	0.97	0.46
1.NB 2	0.96	0.39
HF.PM 1	0.97	0.62
HF.PM 2	0.97	0.67

Table 2 - Wilcoxon test.

	ANB Pre	ANB Post	AFAI Pre	AFAI Post
Median	6.40	6.55	70.87	70.64
Z	0.71		2.33	
p	0.47		0.01	

relation to the skull base. This is a frequent finding in other studies.[1,4,9,13,16,22,26] Some researchers have suggested that this is partly due to the skull base architecture, specifically the Basion-Sella-Nasion angle, which under genetic influence appears more obtuse, favoring a more posterior positioning of the mandible and thereby generating a poor relationship between the basal bones.[15] Evaluation by means of linear measurements showed that the mandible was in a retruded position. This result was found by most studies in the literature.[1,11,16,22]

To verify the maxillo-mandibular relationship the angular measure ANB and the linear measure Wits were employed. The degree of sagittal discrepancy observed by means of the angular measure suggests a spacial disharmony between the apical bases. An increase in this angle was also observed in studies by Santos.[22] The discrepancy observed by means of the linear measure AO-BO (Wits) also points to a basal disharmony. Canuto[3] observed that the higher the ANB, the greater the AO-BO distance, i.e., he found a positive correlation between ANB and Wits.

Proportionality between the skeletal components was evaluated according to the principles advocated by McNamara.[12] The effective length of the maxilla (Co-A) showed a statistically significant difference when compared to the control group sample, revealing an increased maxilla, and corroborating with a previous study.[19] The mandiblar length (Co-Gn) showed a reduced size, which does not differ from the findings of most researchers.[8,13,22] The variable DMM exhibited an unfavorable maxillomandibular relationship, although it did not show statistically significant difference when compared to the control group sample. This can be explained by the fact that DMM is part of a set of measures involving proportionality and this aspect must therefore be taken into account. The anterior lower facial height (ALFH) displayed increased vertical dimension. McNamara[11] posited that excessive vertical development in these individuals is a frequent feature and can be a manifestation of changes in respiratory function. Maia[9] argued that this increase in ALFH occurs due to a more vertical facial growth pattern. Most patients in the experimental group had no lip competence, possibly due to a discrepancy between the jaws (retruded and smaller mandibles). One cannot assert in this study that the patients had a

Table 3 - Means and standard deviations of Student's paired *t* test and random error for the two measurements taken.

VARIABLES	1st MEASUREMENT		2nd MEASUREMENT		N	DAHLBERG	*t*	P
	Mean	SD	Mean	SD				
MAXILLARY COMPONENT								
SNA (°)	83.82	3.11	83.86	3.10	50	1.16	-0.18	0.858
Co-A (mm)	99.35	5.32	99.26	5.34	50	2.88	-0.27	0.782
A-Nperp (mm)	3.61	2.99	3.67	3.02	50	1.52	-0.24	0.810
MANDIBULAR COMPONENT								
SNB (°)	76.73	2.89	77.6	3.14	50	0.84	-0.12	0.898
Co-Gn (mm)	120.86	6.69	117.9	12.02	50	9.18	0.35	0.722
P-Nperp (mm)	-6.4	5.59	0.98	24.9	50	3.18	-0.42	0.670
MAXILLO-MANDIBULAR RELATIONSHIP								
ANB (°)	6.59	1.79	6.75	1.73	50	0.45	-0.18	0.852
Wits (mm)	6.41	2.84	6.43	2.73	50	0.02	-0.34	0.576
DMM (mm)	21.85	3.82	21.73	3.81	50	4.20	0.29	0.766
VERTICAL COMPONENT								
SN.GoGn (°)	33.34	4.54	33.46	4.67	50	1.35	-0.51	0.605
HF. PM (°)	25.75	4.10	25.84	4.04	50	3.61	0.43	0.664
AFAI (mm)	71.02	4.75	70.38	4.60	50	1.56	0.00	0.009*
DENTOALVEOLAR COMPONENT								
1.NA(°)	22.68	8.6	21.90	8.62	50	11.80	-0.32	0.747
1-NA(mm)	4.47	2.85	3.63	2.77	50	0.83	-0.00	0.996
1.NB (°)	32.52	5.61	34.43	5.38	50	6.03	-0.25	0.803
1-NB (mm)	7.81	2.63	7.73	2.29	50	1.02	0.04	0.961

* Statistically significant for $p < 0.05$.

Table 4 - Student's independent *t* test by gender .Experimental group.

VARIABLES	MALE (n=25)		FEMALE (n=25)		P
	Mean	SD	Mean	SD	
Age	138.69	17.77	140.92	16.60	0.650
MAXILLARY COMPONENT					
SNA (°)	84.00	3.42	83.63	2.8	0.684
Co-A(mm)	101.42	5.32	97.12	4.43	0.003*
A-Nperp (mm)	3.36	3.38	3.88	2.57	0.541
MANDIBULAR COMPONENT					
SNB (°)	76.82	2.87	77.40	2.56	0.459
Co-Gn(mm)	122.32	6.07	120.02	5.98	0.182
P-Nperp (mm)	-8.17	6.01	-4.44	3.95	0.012*
MAXILLO-MANDIBULAR RELATIONSHIP					
ANB (°)	7.17	1.94	6.24	1.35	0.054
Wits (mm)	7.37	3.02	5.49	2.06	0.013*
DMM (mm)	20.91	3.31	27.04	2.11	0.171
VERTICAL COMPONENT					
SN.GoGn (°)	33.32	4.76	33.37	4.40	0.965
HF. PM (°)	26.30	4.50	25.71	3.90	0.628
AFAI (mm)	72.34	3.90	69.59	5.24	0.039*
DENTOALVEOLAR COMPONENT					
1.NA(°)	21.28	9.14	22.11	7.93	0.733
1-NA(mm) (°)	3.30	3.15	3.99	2.31	0.387
1.NB (°)	34.51	5.68	34.09	5.13	0.786
1-NB (mm)	8.08	2.41	7.37	2.17	0.279

* Statistically significant for $p < 0.05$.

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Table 5 - Means and standard deviations of the experimental and control groups for the assessed measures.

VARIABLES	EXPERIMENTAL GROUP		CONTROL GROUP		P
	Mean	SD	Mean	SD	
MAXILLARY COMPONENT					
SNA (°)	83.82	3.11	82.95	2.96	0.155
Co-A (mm)	99.36	5.33	92.78	4.19	0.000*
A-Nperp (mm)	3.61	2.99	0.03	2.35	0.000*
MANDIBULAR COMPONENT					
SNB (°)	77.10	2.72	80.25	2.67	0.000*
Co-Gn (mm)	121.22	6.08	116.57	5.68	0.000*
P-Nperp (mm)	-6.38	5.41	-3.55	4.4	0.005*
MAXILLO-MANDIBULAR RELATIONSHIP					
ANB (°)	6.72	1.73	2.7	1.94	0.000*
Wits (mm)	6.38	2.86	-0.16	2.47	0.000*
DMM (mm)	23.85	14.97	23.79	3.27	0.978
VERTICAL COMPONENT					
SN.GoGn (°)	33.34	4.55	31.16	4.4	0.012*
HF. PM (°)	26.02	4.19	23.63	4.05	0.004*
AFAI (mm)	71.02	4.75	64.3	4.22	0.000*
DENTOALVEOLAR COMPONENT					
1.NA (°)	21.68	8.51	25.49	1.69	0.003*
1-NA (mm)	3.63	2.77	4.5	3.95	0.204
1.NB (°)	34.31	5.37	28.41	5.14	0.000*
1-NB (mm)	7.74	2.30	5	1.8	0.000*

* Statistically significant for $p < 0.05$.

history of respiratory disorders. Other parameters are involved, which can be investigated in future studies. In addition, ALFH suffered the greatest variation as indicated by the method error.

The cephalometric measures for the facial pattern (SN.GoGn and HF.PM) exhibited increased values. When the facial pattern was evaluated by the SN.GoGn measure it was found to be in agreement with other investigations.[9,22] Contrary to the results mentioned by some authors,[21] a reduction was observed in the vertical relationship between the jaws and the skull base in the Class II, Division 1 pattern. The mean value found for HF.PM was relatively high, although consistent with results found by Karlsen[8] and Ngan et al.[13] The prevalence of a vertical facial growth pattern is an unfavorable factor in the correction of Class II malocclusion, rendering such treatment a most daunting task. It can be inferred based on these results that the key to a successful treatment should include control of the vertical growth of the maxilla and mandible, or the use of a mechanics that does not produce excessive increments, such as extrusion of the posterior segments.

Among the dentoalveolar component values, all measures showed statistically significant differences, except for variable 1-NA. Changes observed from the evaluation of 1.NA revealed that the upper incisors were lingually inclined. Riedel[16] found no significant differences between patients with Class II malocclusion and normal patients when examining the axial inclination of the incisors. The upper incisors were shown to be well positioned when assessed by 1-NA. Similar findings were reported in other studies.[4,22] The reduced values found for

measure 1.NA when compared to the control group reveals lingual inclination, compensating or masking the discrepancy between the skeletal bone bases. Measure 1-NA, which checks for a possible incisor protrusion, corroborates the maxillary measurements, which indicates that the maxilla was usually well positioned anteroposteriorly and that the teeth supported by this structure were also in a good position. The buccal inclination of mandibular incisors (1.NB) found in this study was also reported by most studies in the literature.[9,21,22] Protruded lower incisors (1-NB), as found in this study, were also the most common feature observed by most researchers,[9,22] although some authors have argued that the lower incisors are usually well positioned.[11,20]

The study revealed dental compensation in the lower incisors, with all relevant measures indicating higher values in the experimental group.

CONCLUSIONS

Based on the methods employed and the results achieved, the following conclusions could be drawn regarding the structural characteristics of Class II, Division 1 malocclusion in Ceará youths:

- Overall, the maxilla exhibited good positioning, with a few protrusive cases.
- The mandible showed a clear predominance of retrusion and sagittal dimensional changes.
- The vertical dimensions of the face were increased.
- The maxillary incisors were well-positioned in their apical bases and slightly lingually inclined.
- The lower incisors were labially inclined and protrusive in relation to their apical bases.
- The existence of gender dimorphism was identified in the following measures: P-Nperp, Co-A, Wits and ALFH.

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Treatment of a Class III growing patient with mandibular prognathism and severe anterior crossbite*

Ricardo Machado Cruz[1]

The treatment of growing patients with Class III skeletal pattern represents one of the greatest clinical challenges for the orthodontist. Several treatment protocols have been proposed, almost all involving rapid maxillary expansion and maxillary protraction. However, there are cases where the maxilla is properly positioned in the anteroposterior direction and there is no transverse discrepancy, featuring only a mandibular prognathism. In such cases, when there is a set of favorable factors such as lack of laterognathism and lower mandibular plane angle, a viable option and which could prove quite interesting is the use of orthodontic chin cup during the night, aiming at trying to redirect the forward growth of the mandible. To have success, it is necessary that this procedure involves pubertal growth spurt and is extended to full skeletal maturation. This case was presented to the board of the Brazilian Board of Orthodontics and Dentofacial Orthopedics (BBO) as part of the requirements to become a BBO Diplomate.

Keywords: Class III. Chin cup. Anterior crossbite. Mandibular prognathism.

INTRODUCTION

Caucasian male patient, 13 years old, in full pubertal growth spurt, with a chief complaint of anterior crossbite and very unsatisfied with his smile appearance. Family history showed the presence of relatives with mandibular prognathism on the mother's family side. The other dental and medical history data reported in the anamnesis did not show any clinical importance.

* Case report approved by the Brazilian Board of Orthodontics and Dentofacial Orthopedics (BBO).

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How to cite this article: Cruz RM. Treatment of a Class III growing patient with mandibular prognathism and severe anterior crossbite. Dental Press J Orthod. 2012 July-Aug;17(4):148-59.

Submitted: May 28, 2012 - **Revised and accepted**: July 4, 2012

» The author reports no commercial, proprietary or financial interest in the products or companies described in this article.

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

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DIAGNOSIS

The patient had a slightly concave facial profile, with no obvious asymmetry, with a slight projection of the lower lip and unsatisfactory smile line, exposing mostly the lower anterior teeth and very little of the upper anterior teeth. He presented a good nasolabial angle, although slightly obtuse, and proper maxillary position in the anteroposterior direction (Fig 1).

In intraoral terms, he had a good dental and periodontal health, with the exception of the buccal surfaces of the upper incisors, which had wear facets, resulting from the dental crossbite. In addition, the maxillary central incisors were in over-eruption. He was in the late mixed dentition, with prolonged retention of deciduous canines and with permanent canines successors still included. The second premolars and second molars were erupting. He also presented an Angle Class I malocclusion, with coincident dental midlines. He had a few diastemas in the lower arch and severe total crossbite in the anterior region (main complaint). All third molars were still included, but the lower right, absent by agenesis (Figs 1, 2, 3).



Figure 1 - Initial facial and intraoral photographs.

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Cephalometrically, the patient had a low mandibular plane angle and a tendency for predominant horizontal mandibular growth, in the counterclockwise direction (SNGoGn = 21° and FMA= 18°). He was diagnosed with a Class III skeletal pattern, due to excessive mandibular growth (ANB = -5°, SNA= 83° and SNB = 88°). The upper incisors were slightly buccal (1-NA = 26) and lower were retroclined (1-NB = 15°), seeking a natural dental compensation for the skeletal deficiency (Fig 4, Table 1).

TREATMENT OBJECTIVES

Considering the patient's main complaint about the total anterior crossbite and the parent's concern about the family history of mandibular prognathism, the main treatment goal was to try to redirect mandibular growth, reducing, if possible, the SNB angle and at the same time, to maintain good maxillary anteroposterior position, because he had a satisfying nasolabial angle.

In the vertical and transverse aspects, the objective was to maintain the dimensions and growth pattern. For this reason, rapid maxillary expansion and protraction using a face mask were not indicated. In dental terms, the basic objective was to perform treatment without extractions, since the patient had no arch perimeter deficiency, and there was concern in aligning, leveling and monitoring the eruption of the teeth which had not erupted, especially the canines. In the incisor region, the objective was to correct their compensatory inclinations in both arches, and to close the lower diastema by means of retraction of anterior teeth, correcting the anterior crossbite.

Since he presented molars in key of occlusion, no movement of these teeth was planned in the anteroposterior direction. With these objectives in mind, improvement of facial and smile esthetics and the functional aspects of occlusion was expected, with control of mandibular growth to reduce the prognathism.

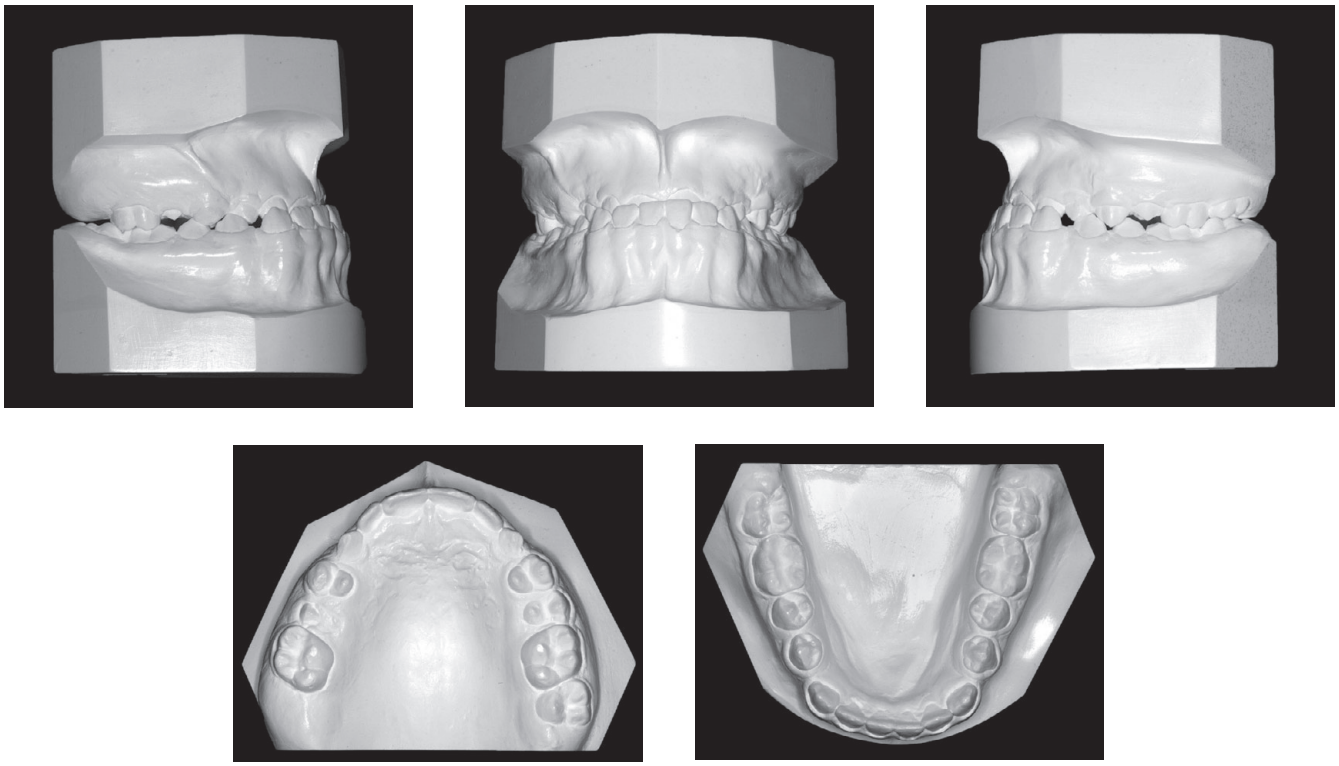


Figure 2 - Initial casts.

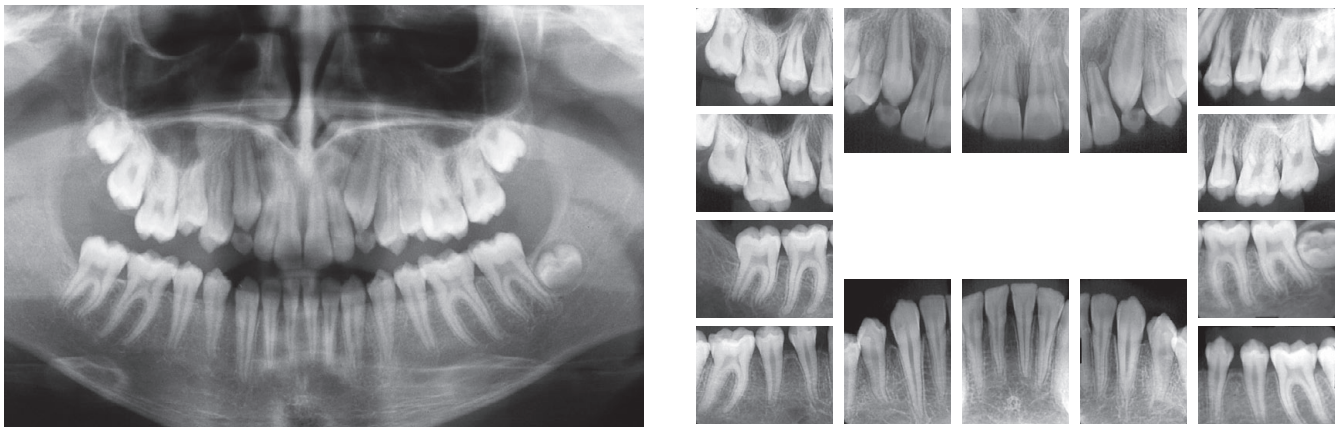


Figure 3 - Initial panoramic and periapical radiographs.

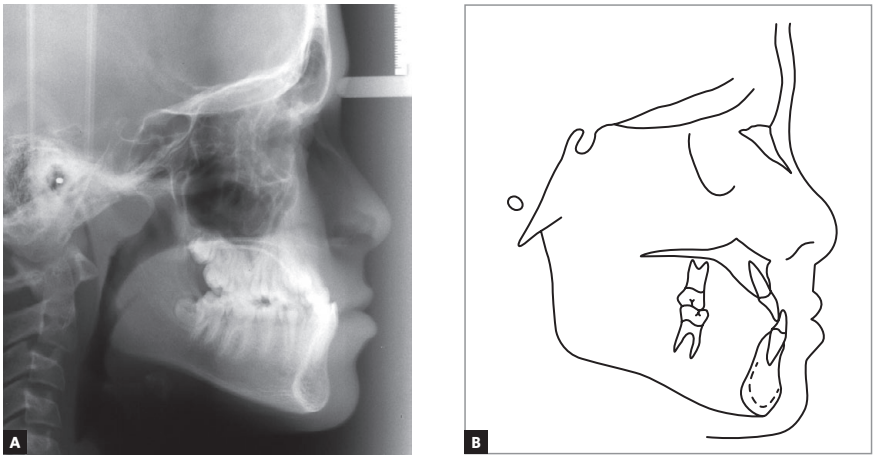


Figure 4 - Initial lateral cephalometric radiograph and cephalometric tracing.

TREATMENT PLAN

A complete corrective Orthodontics a treatment with braces placed on both arches (metal brackets, slot 0.022 x 0.028-in, Straight-Wire system with Roth prescription) was proposed. In the lower arch, anchorage was planned to allow diastema closure with retraction of the anterior teeth, without simultaneous mesial movement of the posterior teeth. The anchorage proposal would use tip back bends on the posterior teeth associated, if necessary, with Class III elastics. The placement of braces would be made, initially, only in the lower arch, due to the impossibility to place orthodontic attachments on the buccal surfaces of upper anterior teeth. Leveling and aligning would be performed in the lower arch, starting from the 0.0175-in coaxial archwire, followed by 0.012-in 0.014-in and 0.016-in NiTi archwires and 0.016-in, 0.018-in and 0.020-in stainless steel archwires. After this phase, the braces are placed on the upper arch. This process in the upper arch is different, starting to place the appliances only in the posterior teeth and two central incisors. A utility TMA 0.019 x 0.025-in arch will be used for small intrusion of the central incisors, with torque control in order to minimize buccal inclination. Next, the lateral incisors would be included in the utility arch. If necessary, bite stops would be installed to enable placement of the upper appliance and correction of the anterior crossbite. Canine eruption would be followed up for complete placement of the upper appliance. Leveling and aligning would be performed in the upper arch with the same sequence used in the lower arch. Then lower canine distalization, to begin diastema closure, with the use of 0.019 x 0.025-in rectangular stainless steel archwires and elastic chains.

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Final space closure would be done with rectangular 0.019 x 0.025-in stainless steel archwires with T loops for incisor retraction. At this stage, anterior crossbite correction will be completed. The case would be finished with 0.019 x 0.025-in stainless steel rectangular archwires with individual bends and torques. If necessary, Class III intermaxillary elastics would be used. Throughout treatment, to control mandibular growth, a chin cup with 500 g force was planned, only at night. As retention, in the upper arch, a wrap-around removable type plate would be used, and the lower intercanine fixed retainer, made with coaxial 0.0215-in wire. At the end, extraction of all three unerupted third molars would be indicated. The patient would have to continue to use the chin cup at night until full skeletal maturation.

TREATMENT PROGRESS

Orthodontic bands were installed on the first four molars, with welded accessories (triple tubes in the upper teeth and double tubes in the lower teeth, all convertible). The chin cup was installed with 500 g of force for night use, and was custom made, after impression of the chin. Thanks to patient cooperation with the chin cup use, after aligning and leveling of the upper and lower arches, the bite was already edge to edge in the anterior region. Then, the retraction of the lower canines, and later, of the incisors was performed. During the entire space closure phase, posterior anchorage was performed by means of tip back bends on the lower molars and wire ligatures in tie-together posteriorly from the distal of the lower canines. At the end of this phase, the patient had normal overjet and overbite. On completion, for the first time, intermaxillary Class III elastics were used in order to improve the intercuspidation, especially in the canine region. Appliance removal occurred as planned. It was recommended that in addition to the removable upper retention plate, chin cup was to be used every night to sleep, until the end of growth, which would be assessed at 18 years of age, by carpal radiography.

At the end of treatment, extraction of third molars was suggested and referral to an expert in Restorative Esthetic Dentistry, to improve the appearance of the buccal surfaces of maxillary incisors — worn after several years in crossbite — as well as for clinical evaluation of demineralization white lesions.

RESULTS

The main treatment objectives were achieved, with correction of severe anterior crossbite and improvement of the Class III skeletal pattern. The aesthetic and functional results were quite satisfactory (Figs 5-8). The treatment time was of approximately three years, and relatively short for the complexity of the case. The decision of not performing rapid maxillary expansion, since there was no transverse deficiency on the perimeter, and maxillary protraction, since it was well positioned in the anteroposterior direction, was correct. Cephalometric superimpositions (Fig 13) showed that there was a mandibular growth redirection, which was predominantly horizontal, to the vertical direction. Significant reduction of the SNB angle, possibly resulting from mandibular clockwise rotation, which increased the mandibular plane angle from 21° to 24°. These changes were the result of disciplined night use of the chin cup. As a final result the ANB angle went from -5° to -1°, a significant reduction (Tab 1).

Regarding the face, there was a significant improvement in all tested parameters, including the smile line was much pleasing with adequate exposure of the upper teeth, and there was an improvement of the profile, with a reduction in the projection of the lower lip (Fig 5, 8). From the dental point of view, molar key of occlusion was kept bilaterally, as planned. The major problem (chief complaint), which was the anterior crossbite, was completely corrected, achieving in the end, good overjet and overbite. The desired buccal inclination of mandibular incisors (dental decompensation) was achieved, but there was also an undesirable buccal inclination of maxillary incisors, which only returned to normal in the evaluation two years post-treatment (Fig 12, 13B and Tab 1). Both arches were properly leveled, especially the lower, whose leveling was by molar extrusion. This fact must also have contributed to the opening of the mandibular plane. In the upper arch, the intermolar distance was maintained and the intercanine width increased of 3.4 mm, due to the exchange of deciduous to permanent canines. In the lower arch, there was a decrease in the intercanine and intermolar distance (respectively 1.6 mm and 1.3 mm) (Figs 5, 6, Tab 2).

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The evaluation of periapical and panoramic final radiographs shows good root parallelism and discrete apical rounding of the upper incisors, consistent with the orthodontic movement (Fig 7).

Due to the family history of mandibular prognathism, the periodic follow-ups were strictly observed in the phase of retention to assess the stability of the occlusion, the end of growth, the development and eruption of third molars, and a possible relapse due to mandibular residual growth.

New follow up records, 26 months after the end of treatment, when the patient was eighteen years and two months old, was requested.

The occlusal situation remained stable and satisfactory, providing functional balance and excursive mandibular movements without interference,

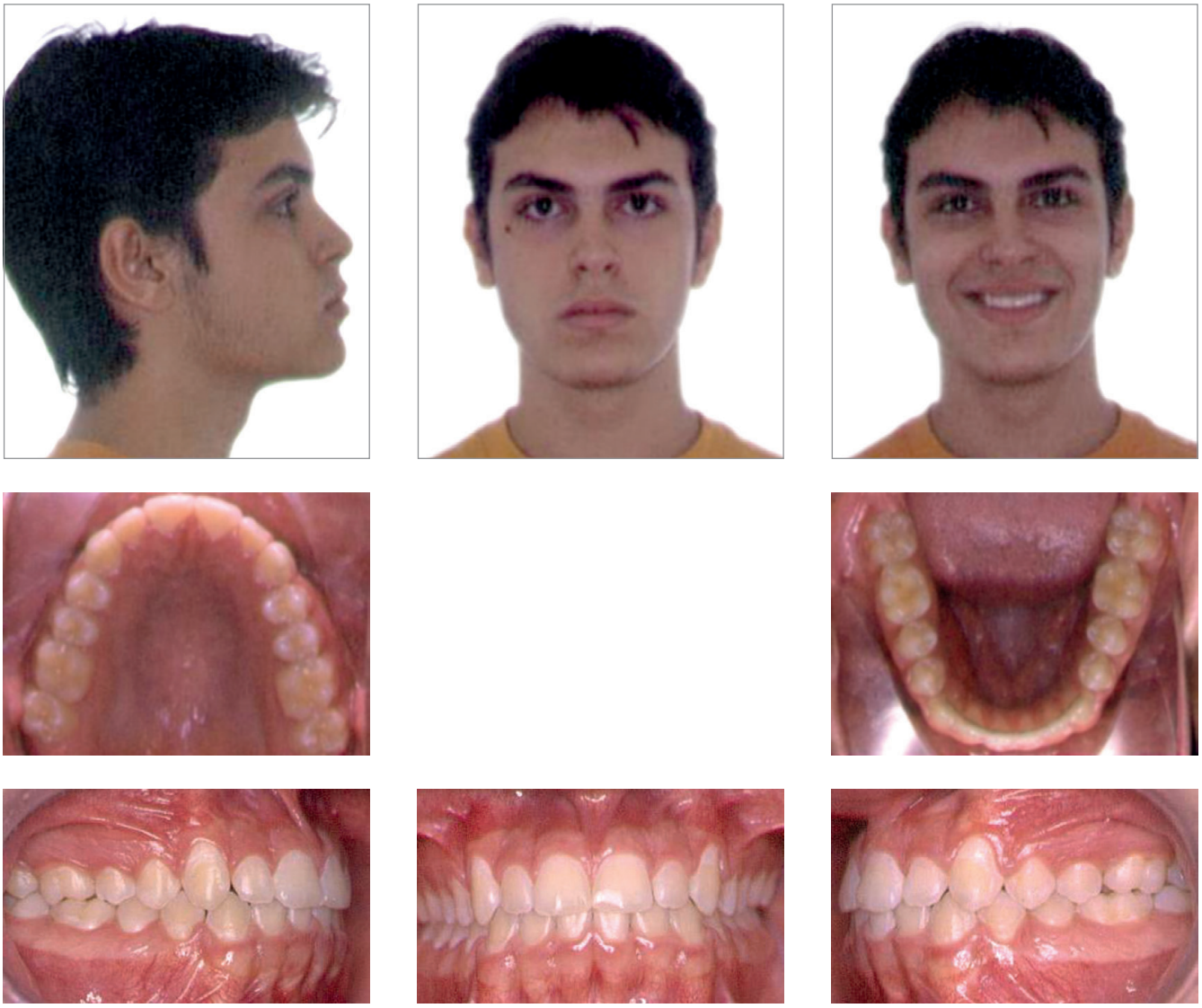


Figure 5 - Final facial and intraoral photographs.

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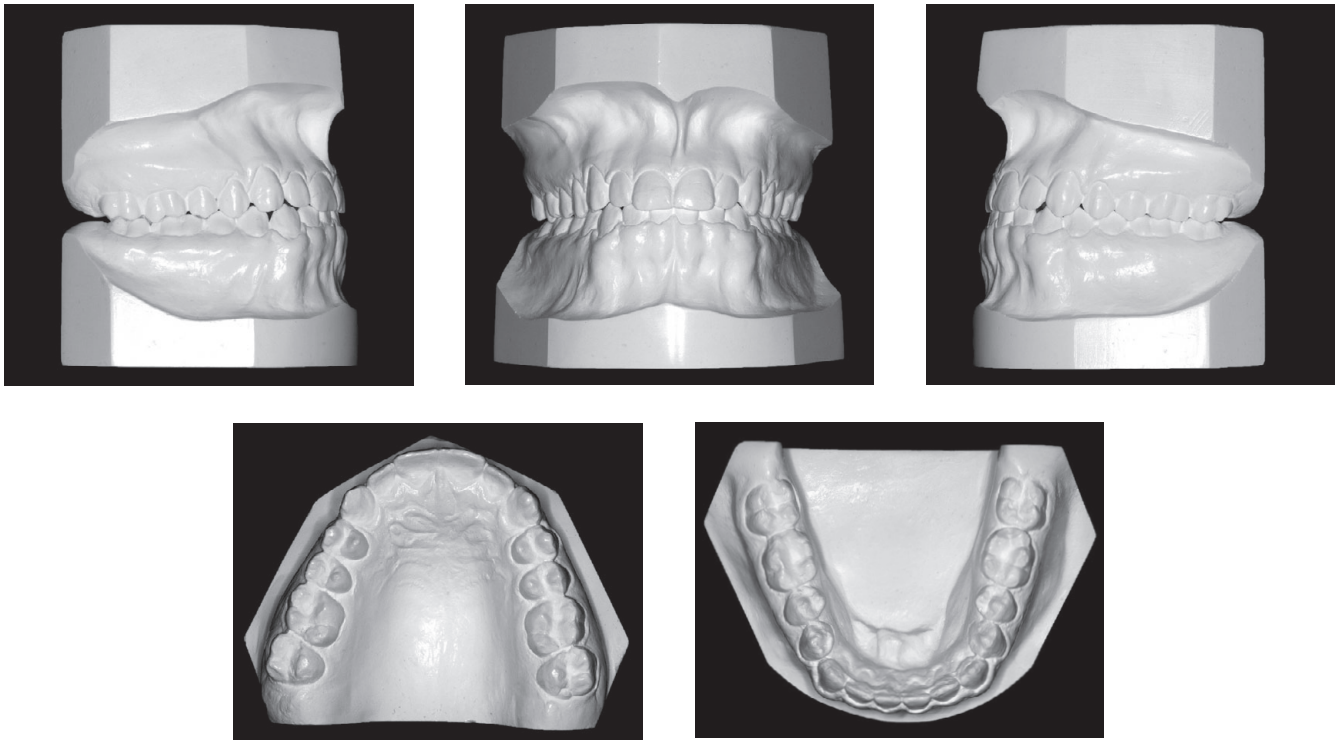


Figure 6 - Final casts.

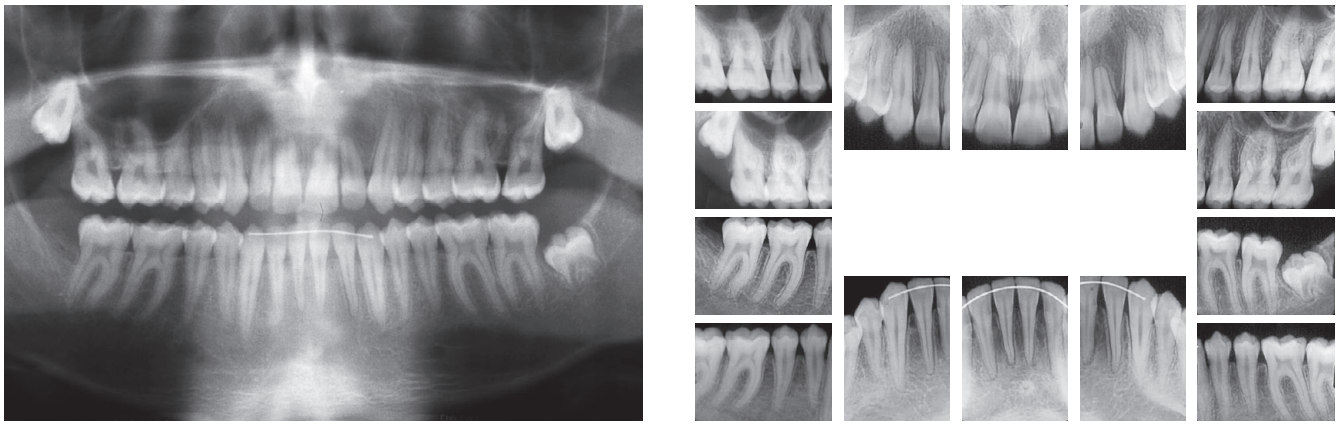


Figure 7 - Final panoramic and periapical radiographs.

and good health of periodontal tissues (Figs 9, 10). Similarly, esthetic and facial smile remained appropriate (Fig 9). The comparison of cephalometric measurements (Tab 1) showed the improvement of some parameters to values closer to normality, as the SNB angle, which decreased 1°, generating an ANB with 0°; the inclination of upper incisors, which decreased 6° and returned to its value from the beginning of treatment without compromising the final occlusion; the inclination of the lower incisors, which reduced 3°, also approaching the initial value, and the facial profile, where there was greater reduction in the projection of the lower lip (Figs 12, 13 and Tab 1).

The removable upper retention was used day and night for two years and intercanine fixed retainer remained, with suggestion of indefinite use.

The night use of the chin cup continued for two years after removal of the appliance, until the patient completed eighteen years of age, and skeletal maturation was confirmed by carpal X-ray (Fig 11).

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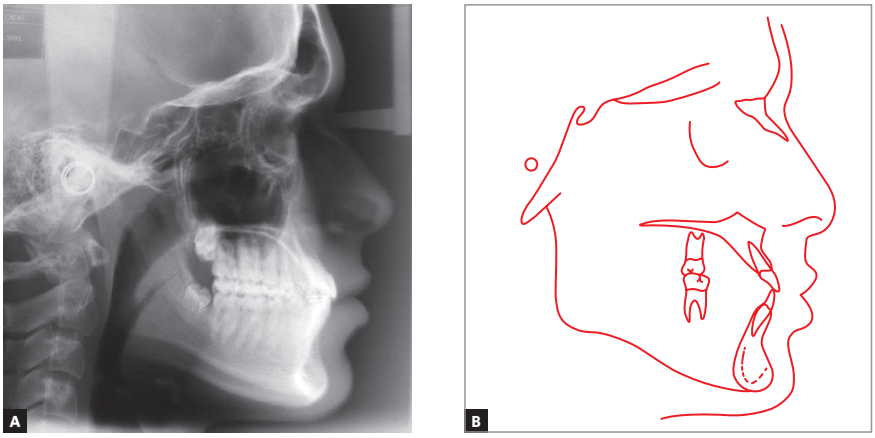


Figure 8 - Final lateral cephalometric radiograph and final cephalometric tracing.



Figure 9 - Two years and two months post-treatment facial and intraoral photographs.

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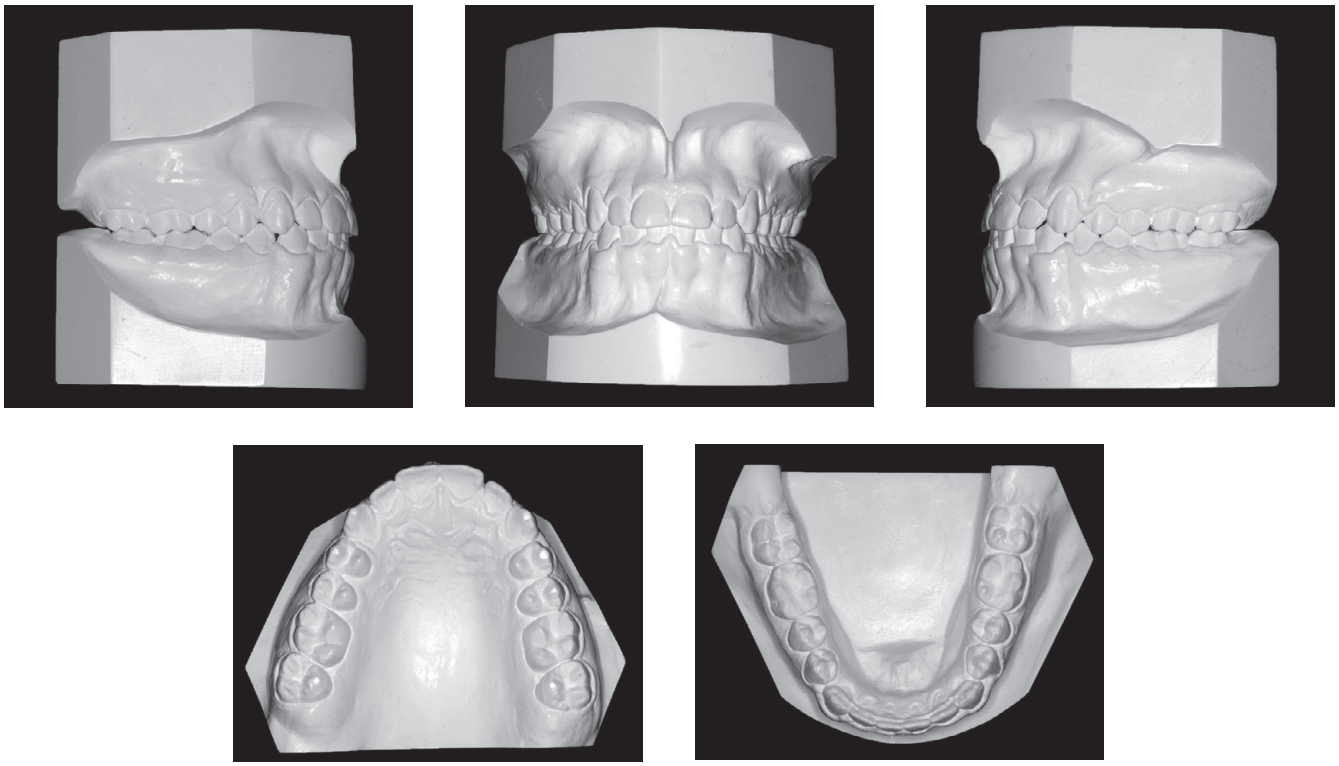


Figure 10 - Two years and two months post-treatment casts.

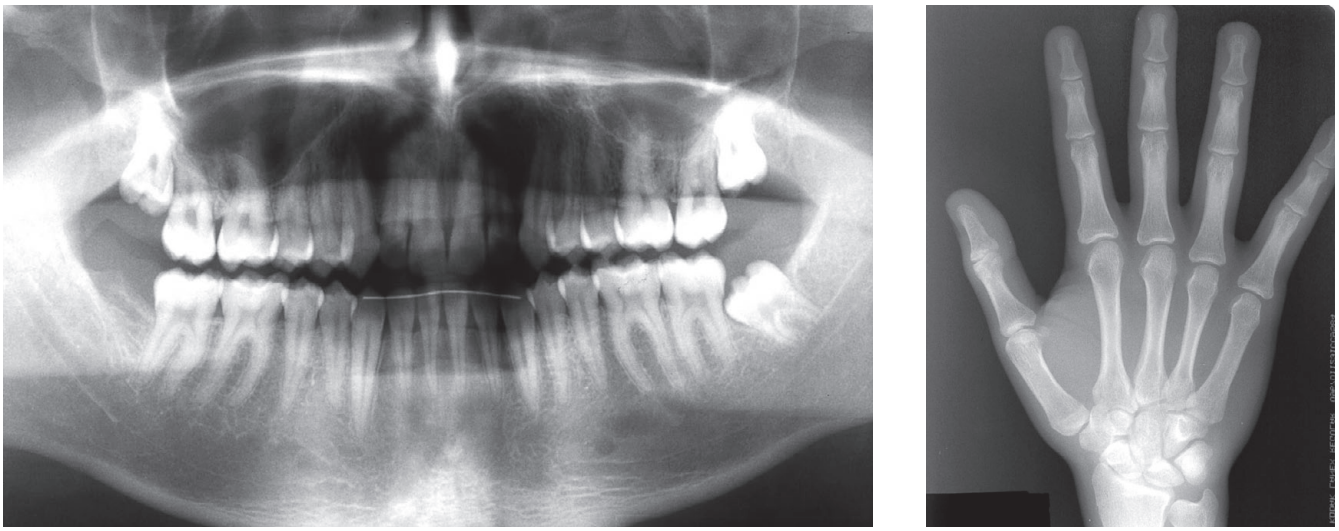


Figure 11 - Two years and two months post-treatment panoramic and hand and wrist radiographs.

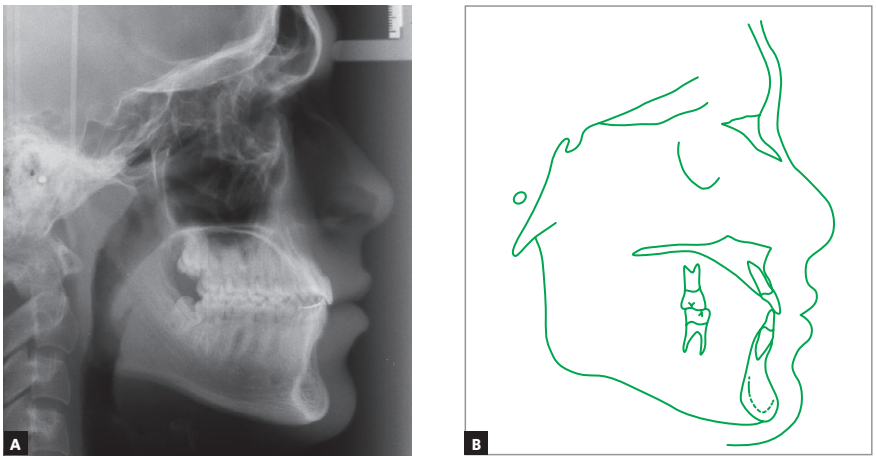


Figure 12 - Two years and two months post-treatment lateral cephalometric radiograph and cephalometric tracing.



Figure 13 - Total (**A**) and partial (**B**) superimpositions of initial cephalometric tracing (black), final (red) and two years and two months post-treatment (green).

This disciplined use of the chin cup, even after the end of active orthodontic treatment was important to control the residual growth of the mandible. Despite the orientation, the patient did not carry out the procedures for esthetic wear on the buccal surfaces of upper anterior teeth or removal of third molars (Figs 9 to 11).

Despite the family history of mandibular prognathism, it is believed that the case is stable. However, the patient remains under control, with periodic annual reassessments.

FINAL CONSIDERATIONS

Class III malocclusion treatment is one of the biggest challenges for the orthodontist in his daily clinical routine. Although mandibular growth being mainly under genetic control, the chin cup can change

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Table 1 - Summary of cephalometric measurements.

	Measures		Normal	A	B	A/B Difference	C
Skeletal pattern	SNA	(Steiner)	82°	83°	82°	1	82°
	SNB	(Steiner)	80°	88°	83°	5	82°
	ANB	(Steiner)	2°	-5°	-1°	4	0°
	Convexity angle	(Downs)	0°	-8°	-6°	2	-6°
	Y axis	(Downs)	59°	60°	62°	2	63°
	Facial angle	(Downs)	87°	89°	85°	4	88°
	Sn-GoGn	(Steiner)	32°	21°	24°	3	23°
	FMA	(Tweed)	25°	18°	17°	1	15°
Dental pattern	IMPA	(Tweed)	90°	86°	92°	6	93°
	1–NA (degrees)	(Steiner)	22°	26°	32°	6	26°
	1–NA (mm)	(Steiner)	4 mm	5 mm	9 mm	4	7 mm
	$\bar{1}$–NB (degrees)	(Steiner)	25°	15°	21°	6	18°
	$\bar{1}$–NB (mm)	(Steiner)	4 mm	2 mm	4 mm	2	3 mm
	$\frac{1}{1}$ – Interincisal angle	(Downs)	130°	142°	129°	13	137°
	$\bar{1}$–APo (mm)	(Ricketts)	1 mm	5 mm	1 mm	4	2 mm
Profile	Upper lip – S line	(Steiner)	0 mm	0 mm	0 mm	0	0 mm
	Lower lip – S line	(Steiner)	0 mm	+3 mm	+2 mm	1	0 mm

growth and morphology of the mandible itself.[1] Studies have shown that the force of the chin cup can change the shape of the jaw, slow condylar growth, improve the position of the chin in the anteroposterior direction and inhibit some maxillary vertical development.[1,5,6,8,9,11] For this to occur, a minimum of two years of therapy with night use is necessary, because the condyles should be at rest when the compressive force is applied.[5,6] The daytime use could lead to a risk of articular disk displacement.[5,6,11] It is recommended that previous records of temporomandibular disorders are performed and that, at the appearance of any sign of joint dysfunction, forces and amount of hours are decreased or even suspend chin cup use.[9]

Results of previous studies have shown that the use of chin cups applying a force of 500 to 600 g,[11,12] hours, on average, can lead to significant changes in mandibular growth patterns during puberty. However, the force duration can vary from 6 to 15 hours/day, and it would not interfere much in the amount of growth that would be inhibited or redirected. The different responses found are mainly due to individual differences to the effects of orthopedic applied forces.[6,11]

Table 2 - Intercanine and intermolar distances (mm).

	Initial	Final	Post-treatment
Upper intercanine distance	33.0	36.4	36.4
Lower intercanine distance	29.6	28.0	33.0
Upper intermolar distance	55.2	54.6	54.0
Lower intermolar distance	47.8	46.5	47.0

However, the changes achieved in the jaw will not be maintained if the use of the chin cup is interrupted before skeletal maturity.[5] Condylar growth is really slowed during the first two years of therapy, but once the force is removed, there is still growth potential in the condylar cartilage, there seems to be an acceleration in condylar growth and a recovery in growth to the initial level. The degree of recovery depends on how much change has already been achieved in the chin cup therapy and how much growth potential is still left.[1,8,9,11]

There is no consensus in the literature regarding the best time to start orthodontic/orthopedic treatment of Class III subjects, but all agree that this

should involve pubertal growth spurt.[3] There seems to be no difference between the final skeletal profiles of individuals who started treatment early, around 7 years old, and those who left to start treatment later in the early pubertal growth spurt.[3,8] When planning such treatment, the clinician must take into account the likely duration of the growth spurt, to establish the time of use of orthopedic mechanics. A recent study showed that, in Class III, the duration of the growth peak is on average longer than five months in the Class I. This difference is statistically significant and, according to the authors, it could explain the greater increase in mandibular length in Class III individuals.[4] In any event, the recommendation is that the use of chin cup should not be less than 12 months.[11] However, after the end of the growth spurt, there seems to be no difference between the growth pattern of a patient with mandibular prognathism and a normal individual.[7]

The choice of using the chin cup in the case reported in this work seemed the best option and, finally, the desired functional and esthetic objectives were achieved. But it should be always taken into consideration that the individual growth responses are not predictable. Not surprisingly, the same orthodontic/orthopedic treatment does not produce the same response in all individuals, since the subjects do not grow in the same manner.

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Changes in occlusal plane through orthognathic surgery

Lucas Senhorinho Esteves[1], Carolina Ávila[2], Paulo José Medeiros[3]

Introduction: A conventional ortho-surgical treatment, although with good clinical results, does not often achieve the desired functional outcomes. Patients with dentofacial deformities, especially those with increased occlusal planes (OP), are also affected by muscle, joint and breathing functional disorders, as well as facial esthetic involvement. The surgical manipulation of the OP in orthognathic surgery is an alternative to overcome the limitations of conventional treatment.

Objective: To report the importance of assessing the occlusal plane during diagnosis, planning and ortho-surgical treatment of patients with facial skeletal deformities and its main advantages.

Conclusion: Although both philosophies of ortho-surgical treatment (conventional and by surgical manipulation of the OP) have presented good results, the selective correction of the OP allows a full treatment of these patients, providing better esthetic and functional results.

Keywords: Occlusal plane. Orthognathic surgery. Ortho-surgical treatment.

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How to cite this article: Esteves LS, Ávila C, Medeiros PJ. Changes in occlusal plane through orthognathic surgery. Dental Press J Orthod. 2012 July-Aug;17(4):160-73.

Submitted: June 13, 2012 - **Revised and accepted:** July 12, 2012

» The authors report no commercial, proprietary or financial interest in the products or companies described in this article.

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

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INTRODUCTION

The correction of dentofacial deformities usually requires maxillomandibular surgery to obtain good esthetic and functional results.[1,2] An important cephalometric tool for diagnosis and clinical interrelationship, often neglected in bimaxillary surgery, is the angulation of the occlusal plane (OP).

The occlusal plane is the angle between the Frankfurt horizontal plane and a line touching the cusps of premolars and second molars. The normal value for adults[1,3,4] is 8 ± 4º. An increased occlusal plane usually is associated with an open mandibular plane, which also occurs in cases of decreased occlusal planes and closed mandibular planes.[1]

The change in the occlusal plane was initially described for treatment of Class II patients with a decreased mandibular plane.[2,5,6] Since then, other types of dentofacial deformities have been treated by surgical modification of the occlusal plane, proving long-term stability and confirming the described functional and esthetic benefits.

One of the biggest advantages of using this tool is the possibility of modifying patients' facial pattern — from brachycephalic and dolichocephalic to mesocephalic — which is not possible without the manipulation of the OP. In conventional treatment plans, usually the change in the OP was an inevitable consequence when conducting any maxillary vertical modification allowing for mandibular autorotation.[1,6,7,8] However, even when we could achieve a good occlusion in centric relation, it was not possible to obtain an optimal inter-relationship between esthetics and function of musculoskeletal and dental structures.[1,6,7,9] Thus, the selective alteration of the occlusal plane allows the maxillofacial surgeon to reestablish the correct and proper jaw function with respect to the cranial base and, consequently, better esthetic results in patients with dentoskeletal deformities.[1,5,6]

This article will discuss the basics of orthodontic treatment and surgical management of patients with deformities that require selective alteration of the occlusal plane.

Occlusal plane x facial type

There are two types of facial pattern suitable for the selective alteration of the OP: Patients with high occlusal plane (dolichocephalic) and those with low occlusal plane (brachycephalic).

High occlusal plane - dolichocephalic patients

The basic characteristics of this type of patient are: 1) increased occlusal plane (> 12º), 2) increased mandibular plane, 3) anterior vertical maxillary excess and / or posterior vertical maxillary deficiency, 4) increased lower anterior face height (LAFH) and / or decreased mandibular vertical ramus; 5) anteroposterior (AP) pogonion deficiency, 6) AP mandibular deficiency; 7) lingually displaced upper incisors, which may allow labial displacement, 8) lingually displaced lower incisors, 9) Class II malocclusion, also occurring in Class I or III, 10) anterior open bite, 11) obstructive sleep apnea from moderate to severe due posterior displacement of the tongue as well as constriction of the throat, in most severe cases (Fig 1).[1,4]

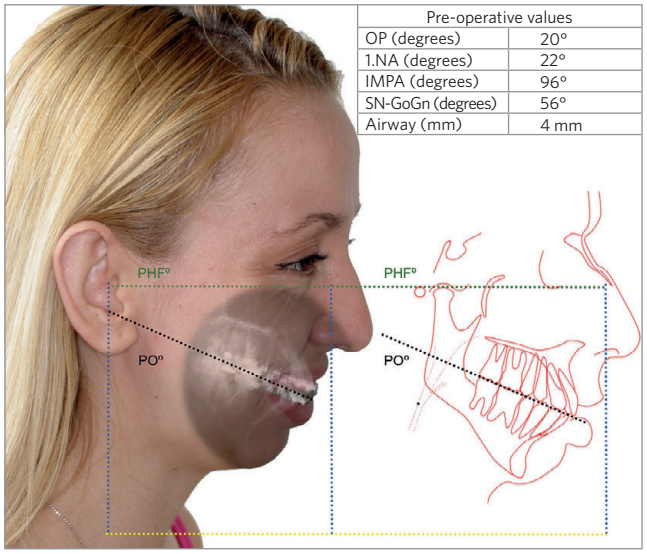
Surgical decrease of the occlusal plane: Counterclockwise rotation of the maxillomandibular complex

With the surgical decrease of the occlusal plane, the following changes occur: 1) reduction of the occlusal plane angulation, 2) reduction of the mandibular plane angulation, 3) buccal inclination of maxillary incisors, 4) decrease of lower incisor inclination (lingual); 5) greater pogonion projection in relation to the lower incisors, 6) clinical definition of mandibular angle projection, 7) increase in posterior facial height, 8) normalization of LAFH, 9) tendency of posterior movement of the paranasal region, 10) upper airway increase, around 40% of the amount of mandibular advancement (Fig 2-5).[1,4]

The choice for the center of rotation influences directly the postoperative facial esthetics. When using the incisal edge of the upper incisors as a fixed point for the counterclockwise rotation of the occlusal plane, the tendency is for a posterior movement of the paranasal region to occur. In contrast, when this center is fixed at point A, the effect is smaller in the paranasal region. However, the inclination of the upper incisors increases, followed by the projection of the upper lip and pogonion.[1,3,6,7] These clinical implications are important at initial planning, aiming at satisfactory esthetic results for patients.

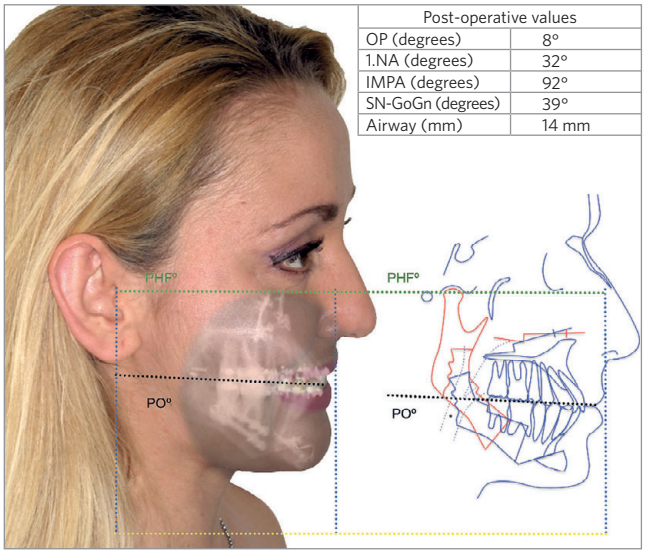
Low occlusal plane – brachycephalic patients

The basic characteristics of this type of patients are: 1) decreased occlusal plane (< 4), 2) decreased mandibular plane, 3) increased projection of the pogonion;



Pre-operative values	
OP (degrees)	20°
1.NA (degrees)	22°
IMPA (degrees)	96°
SN-GoGn (degrees)	56°
Airway (mm)	4 mm

Figure 1 - Clinical and cephalometric correlation: High occlusal plane. Note that the horizontal overbite is incompatible with the facial deformity.



Post-operative values	
OP (degrees)	8°
1.NA (degrees)	32°
IMPA (degrees)	92°
SN-GoGn (degrees)	39°
Airway (mm)	14 mm

Figure 2 - Clinical and cephalometric correlation: Surgical correction of the occlusal plane after counterclockwise rotation of the maxillo-mandibular complex.

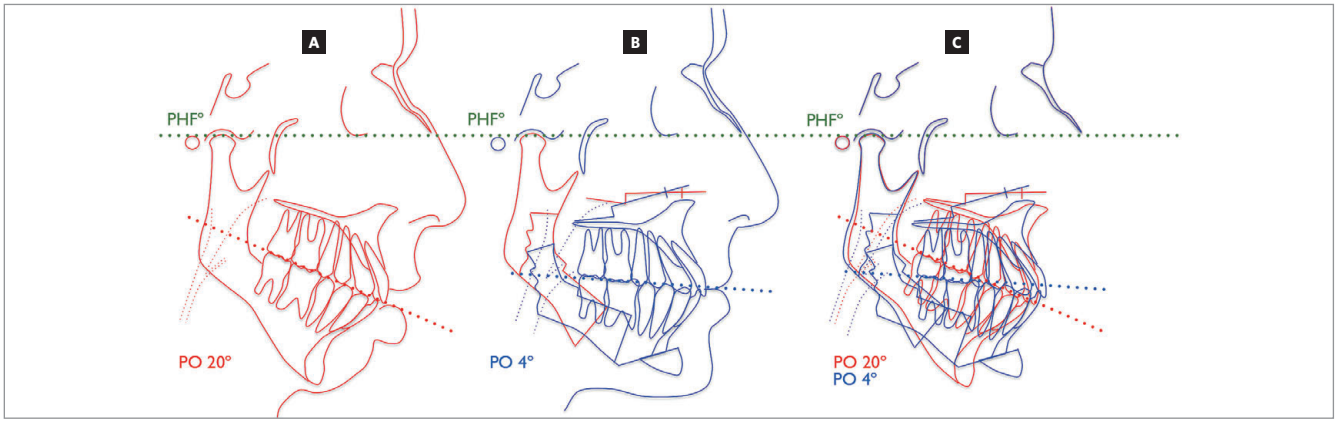


Figure 3 - Cephalometric tracings: **A**) Pre-operative; **B**) Post-operative; **C**) Pre-and post-operative tracing overlays, with the respective OP values.





Figure 4 - Profile Clinical Images: **A**) pre-operative; **B**) post-operative.



Figure 5 - Overlays of clinical images pre and post-operative.

4) clinically well defined mandibular angles, 5) decreased inclination of the upper incisors, which may occur also with increased inclination, 6) decreased inclination of the lower incisors; 7) Class II malocclusion, but can occur with Class I or III, 8) anterior overbite, 9) accentuated lower curve of Spee and eventually reverse upper curve of Spee (Fig 6).[1,4]

Surgical increase of the occlusal plane: Clockwise rotation of the maxillomandibular complex

With the surgical increasing of the occlusal plane, the following changes occur: 1) increased angulation of the occlusal plane, 2) increased angulation of the mandibular plane, 3) decreased inclination of upper incisors, 4) increased inclination of lower incisor; 5) posterior rotation of the pogonion, 6) posterior facial height reduction, 7) advancement of the paranasal region (Fig 7-10).[1,4,5]

As in the maxillomandibular counterclockwise rotation, the anatomical center of rotation also significantly interferes in the esthetic changes promoted by the clockwise rotation of the OP. When using the incisal edge of the upper incisors as a fixed point, there will be major repercussions in the paranasal region, due to their advancement. In contrast, if the center is the A point, the paranasal region will not be affected significantly, but the inclination of the upper incisors will decrease, resulting in posterior movement of the upper lip.[1,3,5,6,7]

Pre-surgical orthodontic objectives

As previously mentioned, the surgical modification of the OP directly interferes in the inclination of upper and lower incisors.[1] Based on this fact, the orthodontic treatment objectives should be established bearing in mind all the repercussions that will

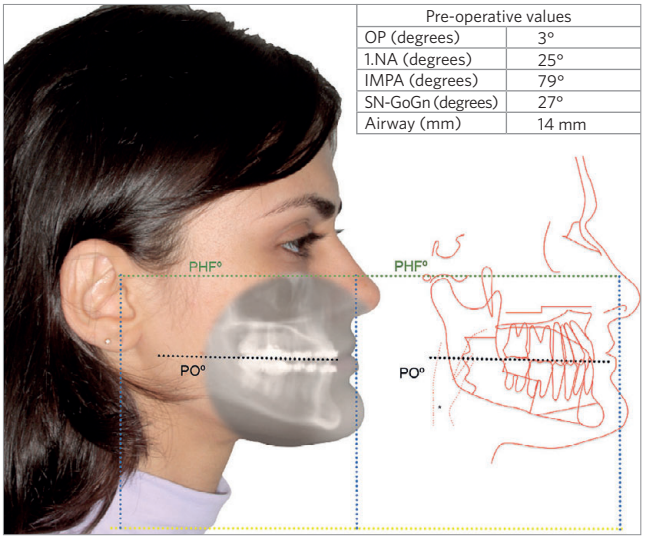


Figure 6 - Clinical and cephalometric correlation: Low occlusal plane. Note that the horizontal overbite is incompatible with the facial deformity.

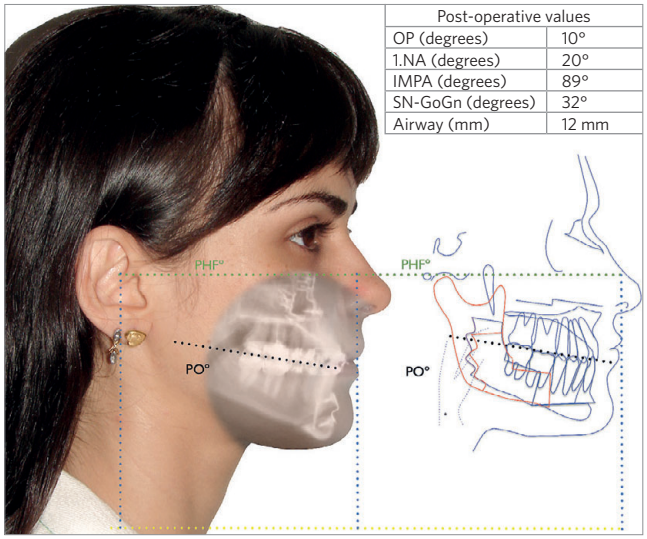


Figure 7 - Clinical and cephalometric correlation: Surgical correction of the occlusal plane after clockwise rotation of the maxillomandibular complex.

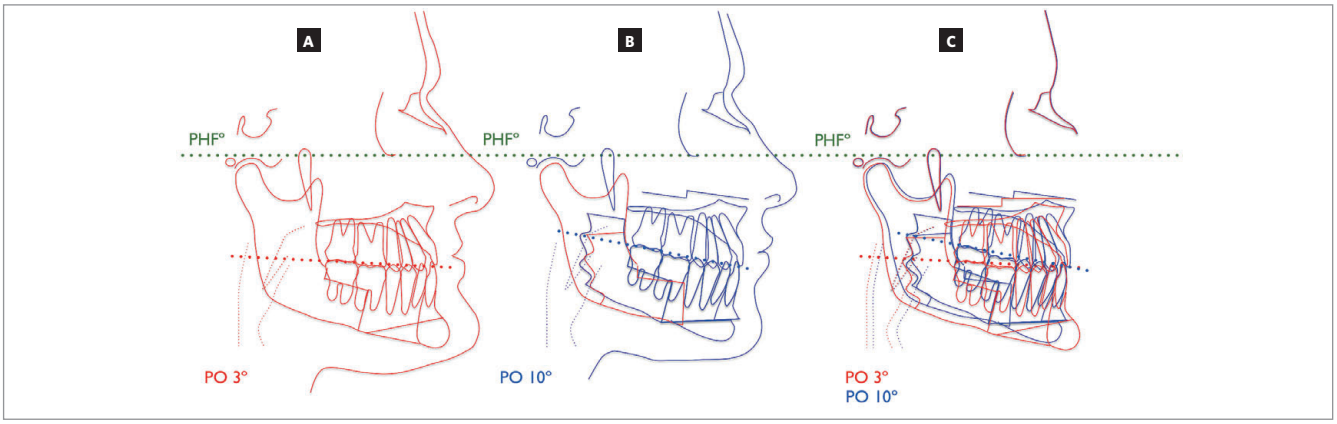


Figure 8 - Cephalometric tracings: **A**) pre-operative; **B**) post-operative; **C**) pre- and post-operative tracing overlays, and respective OP values.





Figure 9 - Profile clinical images: **A**) pre-operative; **B**) post-operative.



Figure 10 - Clinical images overlays.

occur after surgery in the dental arches, in the face and especially in the incisors. Orthodontics should be directed to compensate this movement, which will occur and avoid displeasing surgical results.[4,5,8] At this point, a good relation between orthodontist / surgeon becomes fundamental, so that they can perform together the ortho-surgical planning.

In patients with a high occlusal plane, in which the rotation of the maxillomandibular complex in a counterclockwise direction will be performed, the buccal inclination of the upper incisors and the uprighting of the lower incisors tends to occur. Thus, it is desirable that during orthodontic treatment, there is a decrease in the inclination of the upper incisors, with lingual torque of their crowns lower than the ideal, as well as the buccal torque of the lower incisors greater than normal, so that its axial inclination be corrected during surgery by reducing the OP.[1,4,8]

In patients with low occlusal plane, an increase in the inclination of the upper incisors would be indicated, because of its buccal movement during the preoperative phase of orthodontics. Among the pre-surgical orthodontic objectives is also included the reduction of the lower incisor angle with lingual torque of their crowns. Due to the clockwise surgical alteration and consequent increase in the OP, there will be in equal proportion, a decrease in the angulation of the upper incisors and an increase in lower incisor inclination, returning these measures to an ideal value.[1,4,8] These orthodontic guidelines described for inclination of the upper incisors become higher when maxillary surgical segmentation is performed. This is because when segmenting the maxilla between lateral incisors and canines, there is the possibility of modifying the torque of the tooth-bone segment so the inclination of the previous teeth is normalized.[1,4,5,8]

The determination of pre-surgical orthodontic objectives has significant influence on knowing when the extraction of premolars will be required; when the curves of Spee, pronounced or reverse, will be leveled orthodontically or surgically; and when intra-arch orthodontic procedures are necessary to obtain adequate tooth positions.

CASE REPORTS

High occlusal plane – dolichocephalic patient

Male patient, 20 years-old, with the chief complaint of occlusal disharmony and elongated face.

In the facial clinical examination, a long face pattern III was observed, symmetrical, increased lower anterior face height (LAFH), paranasal deficiency, good nasal support, reversed interlabial relation, gingival smile and lip incompetence. The intraoral clinical examination showed a Class III dental relationship for molars and canines, with upper and lower crowding (Fig 11).

The cephalometric analysis confirmed the clinical impression, showing a skeletal Class III, characterized by an anteroposterior deficiency of the maxilla and maxillomandibular clockwise growth, with an increased occlusal plane. The upper and lower incisors were well positioned (Fig 12A).

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The chosen treatment plan was the ortho-surgical correction of dentofacial deformity, aiming apart from the malocclusion correction, also the facial pattern modification by surgical alteration of the occlusal plane in a counterclockwise direction (Fig 12B).

The patient underwent orthodontic treatment with the preparation of the dental arches for orthognathic surgery. Alignment, leveling and decompensation of the axial inclinations without dental extractions were conducted. The sequence of orthodontic treatment and surgery is shown in Figures 13-19.

Low occlusal plane – brachycephalic patients

Female patient, 19 years-old, with the main complaint of occlusal disharmony, the smile and speech deficiency.

In the facial clinical examination, a Pattern III face was observed, mandibular asymmetry, paranasal deficiency and poor nasal support. The clinical examination

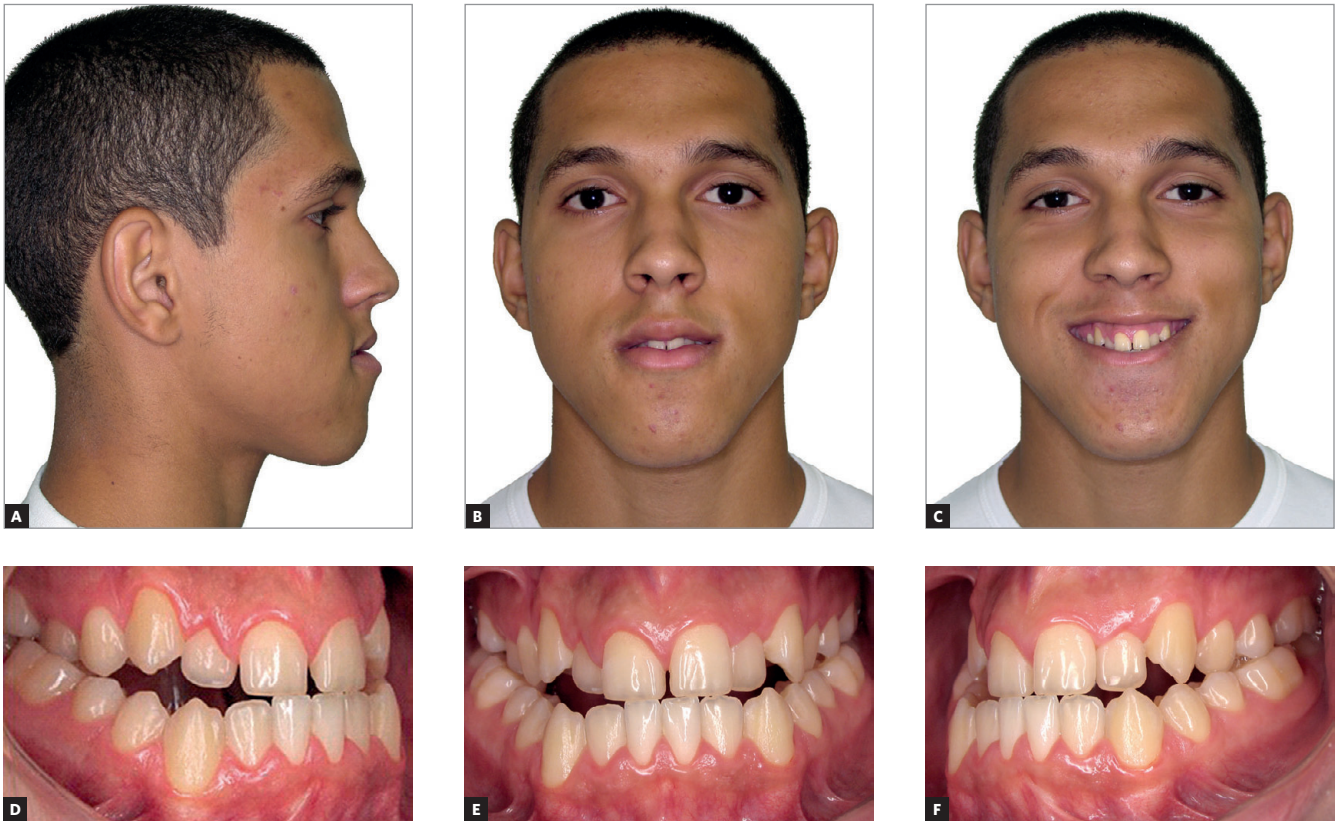
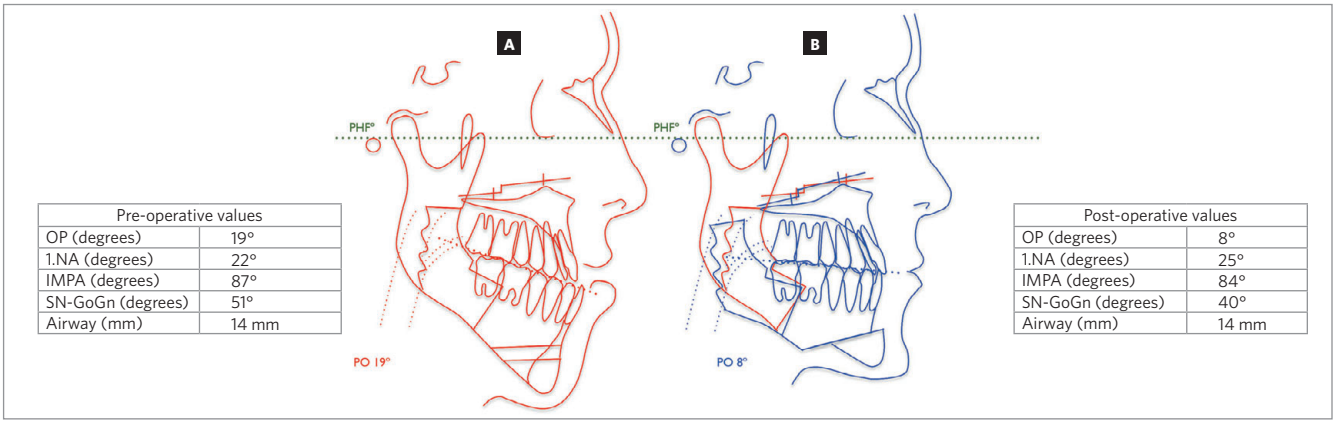


Figure 11 - **A**, **B**, **C**) Initial facial clinical aspect. **D**, **E**, **F**) Intraoral initial images.



Pre-operative values	
OP (degrees)	19°
1.NA (degrees)	22°
IMPA (degrees)	87°
SN-GoGn (degrees)	51°
Airway (mm)	14 mm

Post-operative values	
OP (degrees)	8°
1.NA (degrees)	25°
IMPA (degrees)	84°
SN-GoGn (degrees)	40°
Airway (mm)	14 mm

Figure 12 - Surgical correction of the occlusal plane after counterclockwise rotation of the maxillomandibular complex. **A**) Pre-operative cephalometric tracing; **B**) post-operative cephalometric tracing.

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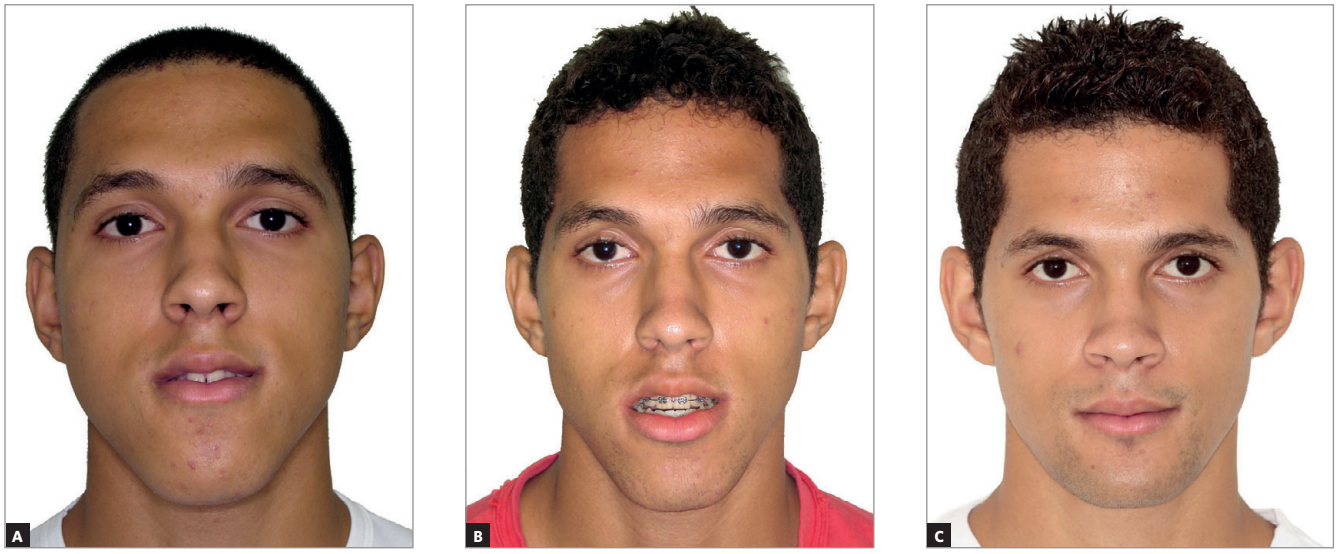


Figure 13 - Frontal facial clinical follow up with lips at rest: **A**) Initial, **B**) pre-operative and **C**) post-operative.



Figure 14 - Frontal facial clinical follow up with sealed lips: **A**) Initial, **B**) pre-operative and **C**) post-operative.

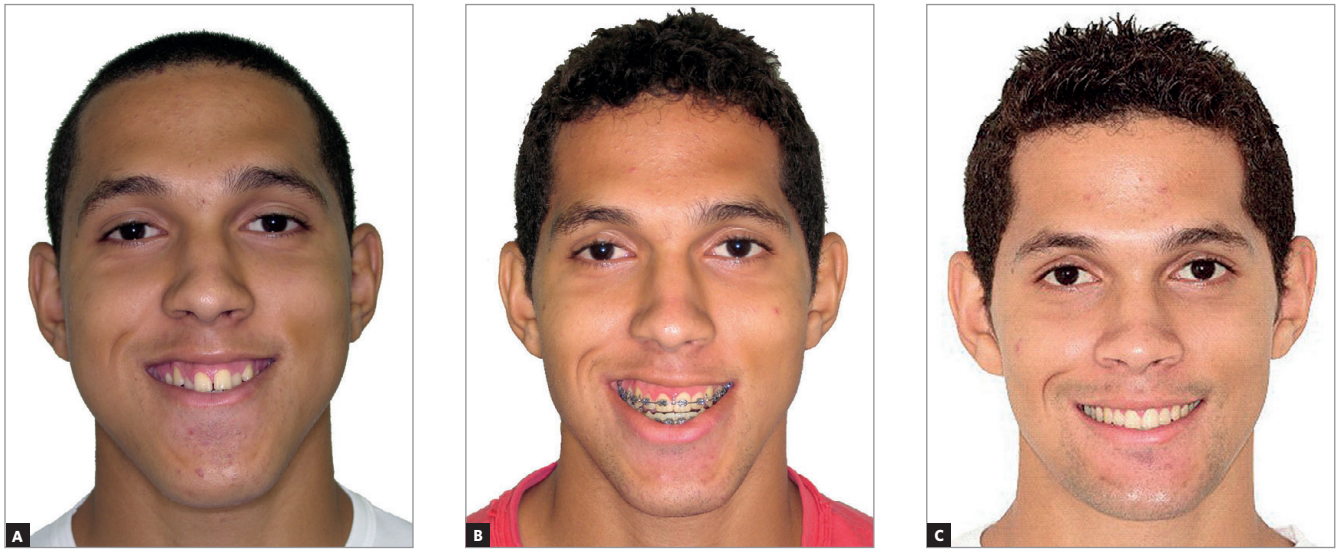


Figure 15 - Frontal facial clinical follow up smiling: **A**) Initial, **B**) pre-operative and **C**) post-operative.

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Figure 16 - Clinical follow up of facial profile with lips at rest: **A**) Initial, **B**) pre-operative and **C**) post-operative.



Figure 17 - Clinical follow up of facial profile with sealed lips: **A**) Initial, **B**) pre-operative and **C**) post-operative.

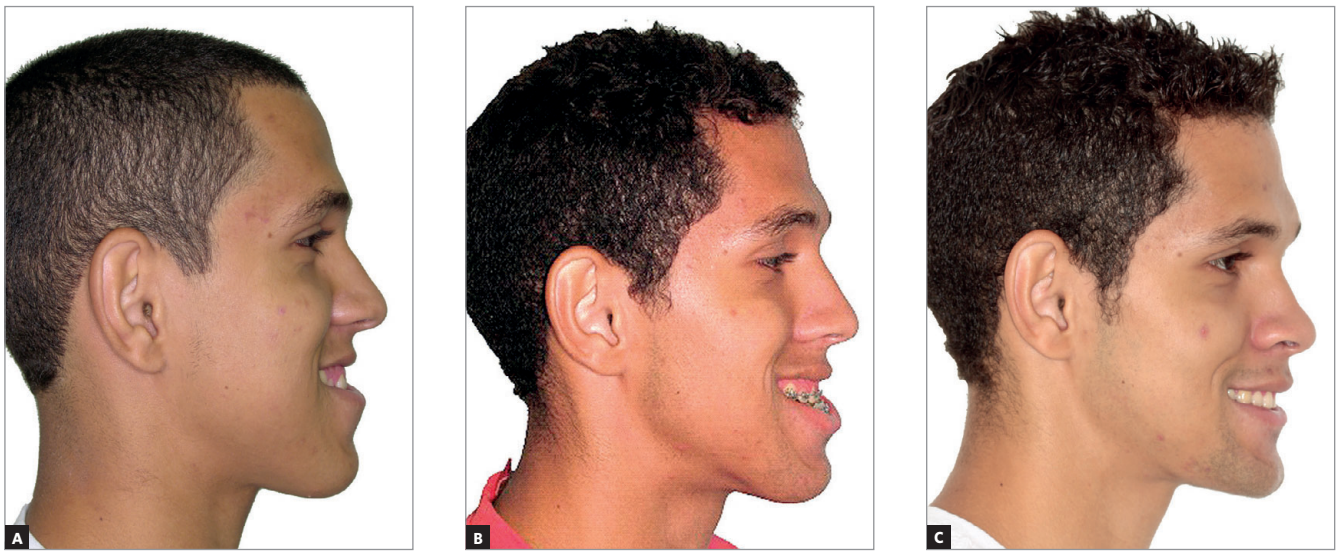


Figure 18 - Clinical follow up of facial profile smiling: **A**) Initial, **B**) Pre-operative and **C**) post-operative.

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Figure 19 - Occlusal clinical follow up: **A**, **B**, **C**) Initial; **D**, **E**, **F**) after pre-operative orthodontics; **G**, **H**, **I**) post-operative.

showed an intraoral dental relationship of Class III, for molars and canines, lower midline shift to the left, with a slight axial offset of the upper and lower incisors (Fig 20).

The cephalometric analysis confirmed the clinical impression, showing a skeletal Class III, characterized by maxillary anteroposterior and vertical deficiency and maxillomandibular counterclockwise growth, with the occlusal plane decreased. The upper incisors were buccally inclined, while the lower were retroclined (Fig 21A).

The treatment plan chosen for the patient was the surgical-orthodontic correction of the dentofacial deformity, aiming, not only the treatment of the malocclusion, but also the facial pattern modification by surgical clockwise alteration of the occlusal plane (Fig 21B).

The patient underwent orthodontic treatment intending the preparation of the dental arches for orthognathic surgery. Alignment, leveling and decompensation of dental axial inclinations without extractions were performed.

The sequence of orthodontic treatment and surgery is shown in Figures 22-28.

DISCUSSION

Although conventional orthognathic surgery can obtain adequate esthetic results, many patients still remain – not only esthetically, but also functionally – far from the ideal[2]. This often occurs by maintaining the incorrect relationship between points A and B, i.e., by not correcting the OP and therefore the maxillary and mandibular planes.[8]

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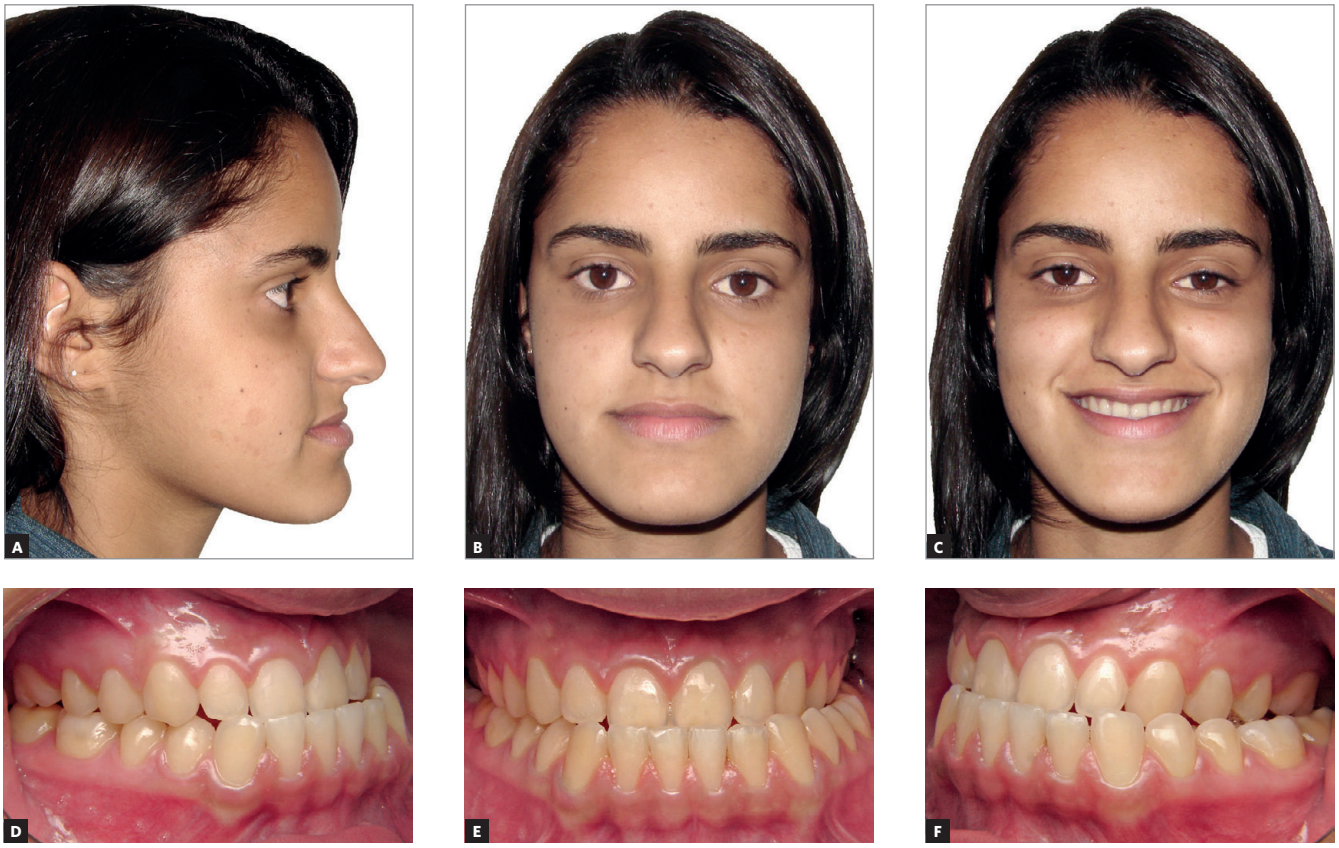
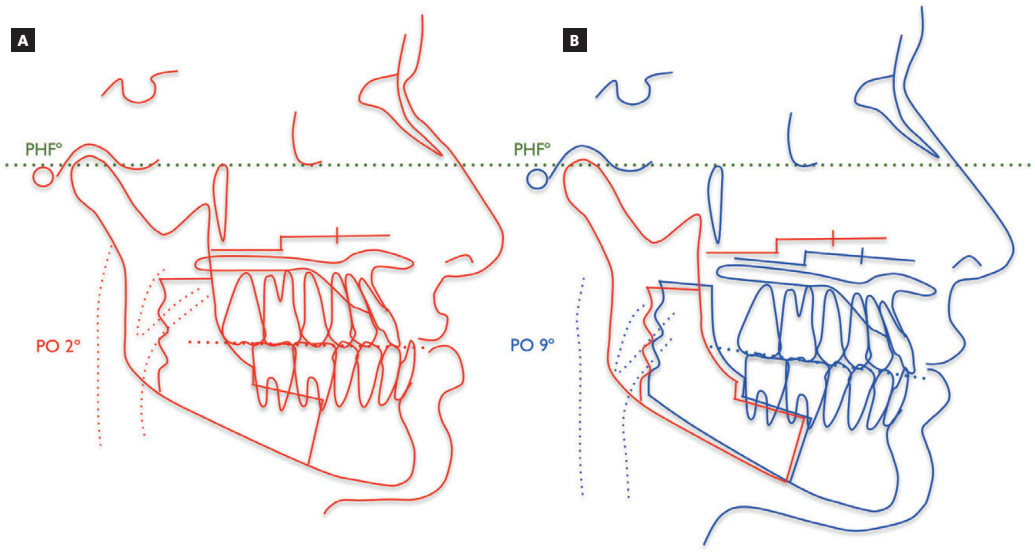


Figure 20 - **A**, **B**, **C**) Initial facial clinical appearance. **D**, **E**, **F**) Initial intraoral appearance.



Pre-operative values	
OP (degrees)	2°
1.NA (degrees)	35°
IMPA (degrees)	86°
SN-GoGn (degrees)	25°
Airway (mm)	14 mm

Post-operative values	
OP (degrees)	9°
1.NA (degrees)	25°
IMPA (degrees)	82°
SN-GoGn (degrees)	39°
Airway (mm)	14 mm

Figure 21 - Surgical correction of the occlusal plane after clockwise rotation of the maxillomandibular complex: **A**) Pre-operative cephalometric tracing, **B**) post-operative cephalometric tracing.

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Figure 22 - Frontal facial clinical follow up with lips at rest: **A**) Initial, **B**) pre-operative and **C**) post-operative.



Figure 23 - Frontal facial clinical follow up with sealed lips: **A**) Initial, **B**) pre-operative and **C**) post-operative.



Figure 24 - Frontal facial clinical follow up smiling: **A**) Initial, **B**) pre-operative and **C**) post-operative.

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Figure 25 - Clinical follow up of facial profile with lips at rest: **A**) Initial, **B**) pre-operative and **C**) post-operative.



Figure 26 - Clinical follow up of facial profile with sealed lips: **A**) Initial, **B**) pre-operative and **C**) post-operative.

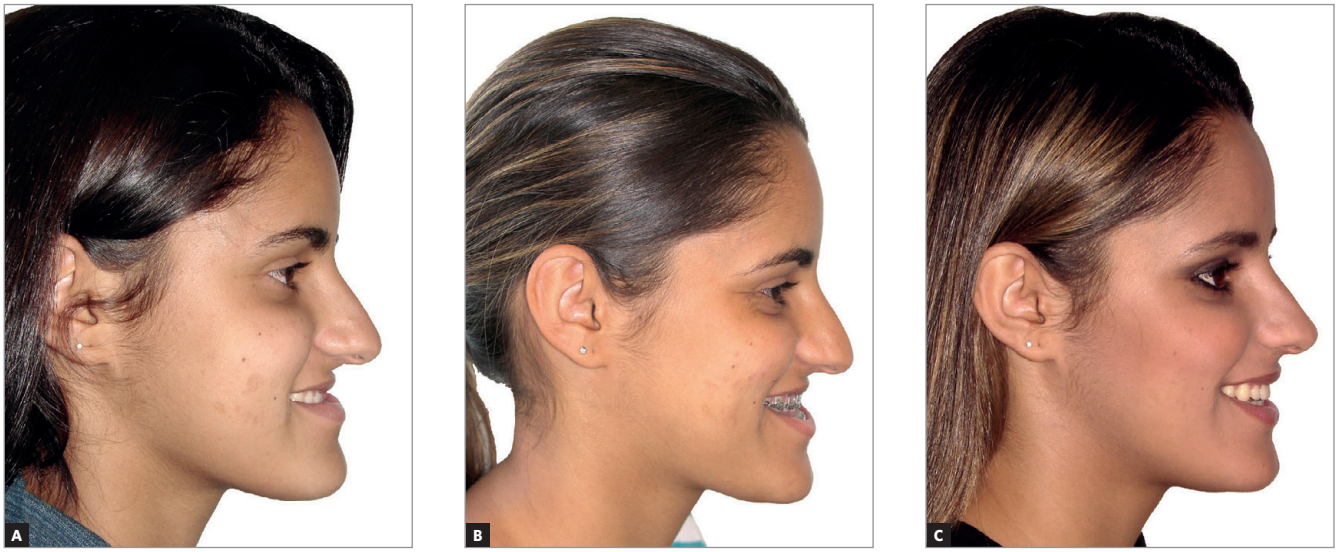


Figure 27 - Clinical follow up of facial profile smiling: **A**) Initial, **B**) pre-operative and **C**) post-operative.

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Figure 28 - Occlusal clinical follow up: **A**, **B**, **C**) Initial; **D**, **E**, **F**) after pre-operative orthodontics; **G**, **H**, **I**) post-operative.

As an example, the traditional orthognathic surgery for correction of vertical maxillary excess with anterior open bite was based on the Le Fort I osteotomy for intrusion (higher in the posterior region) and consequent mandible auto-rotation without performing any osteotomy in the mandibular rami. However, this mandible auto-rotation is often insufficient to achieve adequate intermaxillary relationship and great esthetic results.[1,5,7,9]

The use of the OP as a guide for planning an ortho-surgical treatment of patients with dentofacial deformities has advantages, about which we discuss below. Besides those previously mentioned, we must take into account the functional improvement of these patients, especially in breathing pattern.[1,10]

A consensus already established in literature is the positive correlation between the counterclockwise rotation of the maxillomandibular complex and the breathing pattern improvement of these patients. This type of treatment, when associated with bimaxillary advancement, is considered the gold standard in the treatment of severe respiratory disorders such as Obstructive Sleep Apnea Syndrome[1,10] (which causes secondary changes in quality of life of affected patients, such as elevation of blood pressure, daytime sleepiness and loss of performance at school or at work, and even death risk).[11]

Another advantage of the selective surgical manipulation of the OP to be considered is the fact of not being required to obtain expressive overjets to achieve good results with surgical skeletal movement, as indicated in conventional orthognathic surgery. You can change the facial pattern of patients and obtain functional and esthetic satisfactory results in patients with Class I occlusion, as shown in cases 1 and 2 of this article.[12]

This fact changes the extraction standards established in orthodontic preparation for ortho-surgical conventional treatment demonstrated in clinical cases described in this article. Since there is usually no need to obtain expressive overjets, premolar extraction is limited to cases with severe crowding and exacerbated incisor inclinations, thus decreasing the total time of pre-surgical orthodontics and possible side effects in the periodontium – for example, root resorption.

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The counterclockwise or clockwise OP selective alteration in bimaxillary surgery is considered stable in patients with healthy temporomandibular joints and when using the appropriate surgical and rigid fixation technique.[1-4,8,11,12]

CONCLUSION

The surgical manipulation of the occlusal plane is a tool that should be considered in the initial planning stages and surgical planning of all patients with dentofacial deformities. The advantages are the possibility of changing the facial pattern regardless of the sagittal relationship of the molars and canines, the treatment of respiratory disorders of the upper airways and achievement of optimal esthetic results.

ACKNOWLEDGEMENT

We thank Dr. Pedro Bittencourt, Dr. Priscilla Esperão, Dr. Renata Viana and Dr. Maria Nicia Negrão for the teamwork and patient care presented in this article.

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Clinical trials are among the best evidence for clinical decision making. To be considered a clinical trial a research project must involve patients and be prospective. Such patients must be subjected to clinical or drug intervention with the purpose of comparing cause and effect between the groups under study and, potentially, the intervention should somehow exert an impact on the health of those involved.

According to the World Health Organization (WHO), clinical trials and randomized controlled clinical trials should be reported and registered in advance.

Registration of these trials has been proposed in order to (a) identify all clinical trials underway and their results since not all are published in scientific journals; (b) preserve the health of individuals who join the study as patients and (c) boost communication and cooperation between research institutions and with other stakeholders from society at large interested in a particular subject. Additionally, registration helps to expose the gaps in existing knowledge in different areas as well as disclose the trends and experts in a given field of study.

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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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Yours sincerely,

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