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Articles

Online Articles

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Breathing: old and fresh breezes in Orthodontics

Flavia **Artese**[1]

Upon concluding a lecture on dentoalveolar bimaxillary protrusions and their treatment possibilities, I was asked many questions about the association between the reduction in the volume of dental arches after extractions and the development of respiratory disorders, notably obstructive sleep apnea (OSA). I admit that at that time I was not aware of the current evidence on the correlation between these two factors, which led me to question whether Orthodontics was causing OSA by retracting anterior teeth for almost a century. Although I searched for the answers to those questions, another one did not leave my mind. In that lecture, among the options for treating bimaxillary protrusions, the full distalization of dental arches using skeletal anchorage was also presented. And, although the dental arches are retracted, its possible association with OSA was not discussed in the question session. Would there be differences between these treatment possibilities with regard to the final position of the incisors in the anteroposterior direction?

The final results of bimaxillary protrusion cases published in the Special Topic of this issue of the DPJO (page 66) by Dr. Henrique Vilella, treated without extractions, and with arch distalization anchored on intra or extra-alveolar mini-implants, are very similar to cases treated with premolar extractions. This suggests that, in spite of effectively retracting the anterior teeth with both possibilities of treatment, we still carry biases with regard to tooth extractions. Are they the only cause in reducing the volume of dental arches, and not full arch distalization? And to what extent are changes of the dentoalveolar region in the sagittal direction associated with the effects on the airways?

The fact is that this association still seems to be unclear. There are few studies evaluating changes in the anteroposterior position of the incisors and their impact on breathing,[1] with inconclusive results due to heterogeneous samples and substitutive outcomes, such as airway volume instead of apnea and hypopnea indexes (AHI) and oxygen saturation. In fact, changes in basal bone, such as those obtained from surgical maxillomandibular advancements, seem to have more robust evidence on their positive impact on the treatment of OSA, than just tooth movements in the sagittal direction.[2]

Some aspects of OSA were already described in the 19th century as Pickwick's Syndrome, in reference to the little fat boy, Joe, in Charles Dickens's novel "The Pickwick Papers". However, it was in a 1981 Lancet paper that Sullivan and collaborators published the first use of continuous positive airway pressure (CPAP) as a way of treating OSA.[3] Since then, this condition has been approached and integrated with several specialties in the health field, as it is a multifactorial problem and often requires multidisciplinary treatment. It is known that in patients with high indexes of apnea and hypopnea, the gold standard treatment is the use of CPAP,

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although adherence to this approach is low. In this respect, Orthodontics can help reduce the severity of AHI with mandibular advancement devices. There are several models and with different characteristics, such as the DIORS device presented in the article by Drs. Barbosa and collaborators in this issue (page 44). Its conclusion is quite pertinent and agrees with the results of the systematic review that establishes that the use of mandibular advancement devices will not reach CPAP results, but serve instead as an alternative treatment, even with smaller results in AHI in patients resistant to CPAP.[4]

Despite the importance given to Orthodontics in recent decades in its relationship with OSA, whether in terms of its treatment or prevention through our therapeutic choices, which seems very new, has indeed been available for a long time by the hands of Andrew Haas. I had the unique opportunity to listen to him at one of the Angle Society meetings, where he told how the idea of rapid maxillary expansion (RME) also arose from the interest of otolaryngologists with the intention of changing the internal anatomy of the nose. His classic papers[5,6] report an increase in the volume of the nasal cavity after RME, resulting in the clinical improvement of mouth-breathing patients.

In this issue of DPJO, Dr Bruno and collaborators evaluated the changes in the morphology of the nasal septum after RME, and did not observe changes neither in the volume nor in the deviation of the septum (page 51). However, although we cannot change the anatomical aspects of the nasal septum, we can be the first specialists to diagnose the consequences of oral breathing in children, such as constricted upper arches, posterior crossbites and high palates. Thus, we have a huge responsibility to explore even further this diagnosis, either through a specific questionnaire for the child's respiratory evaluation, or by a referral to an otolaryngologist.

If we still do not know whether dental changes in the sagittal direction have an influence on breathing, for transverse expansions the evidence is very clear. A systematic review published by Camacho et al.[7] shows that RME consistently improves both AHI and minimum oxygen saturation in the short-term, that is, during a follow-up of 3 years.

The search for fresh breezes in Orthodontics has been within our reach since the 60s. In fact, what we have new is the diagnostic approach towards breathing, since using a routine procedure, such as RME, we are able to correct a very serious problem. Even more important is to know the consequences of OSA and share our diagnosis with a multidisciplinary group, where the scope of our specialty goes beyond occlusion and aesthetics, ensuring basic functions for a healthy life of our patients.

Good reading!

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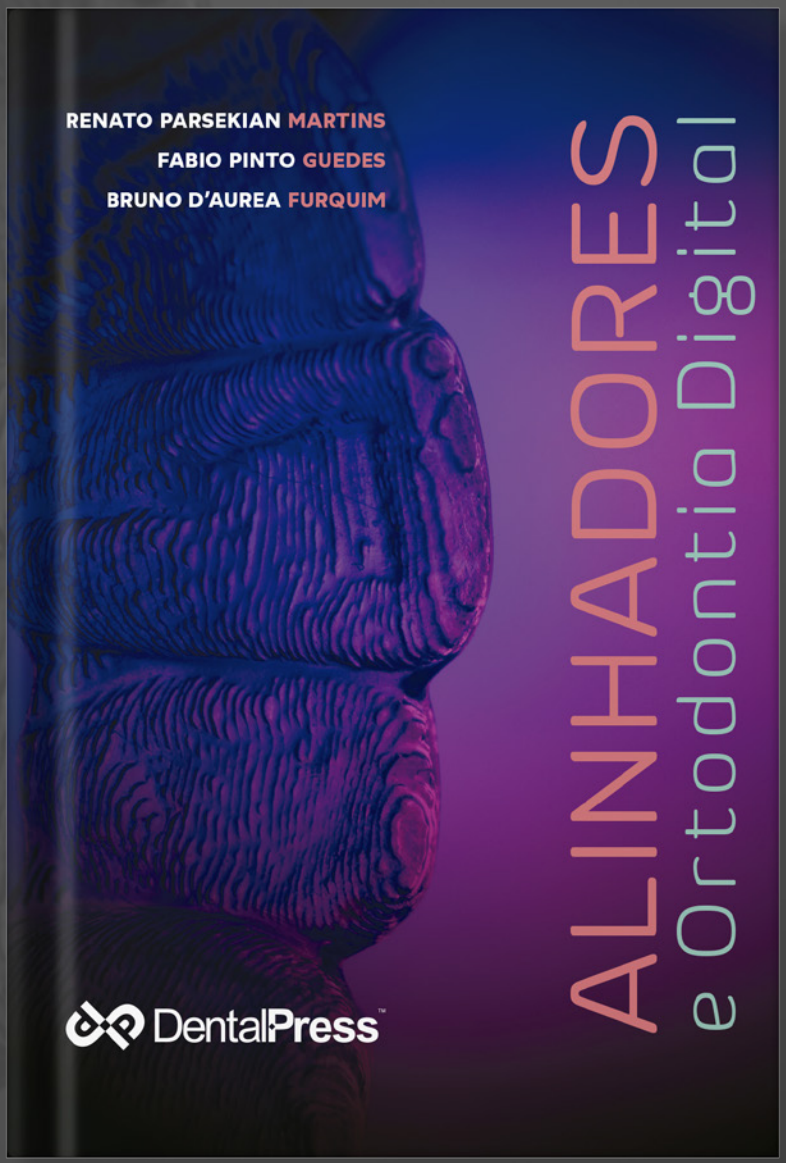

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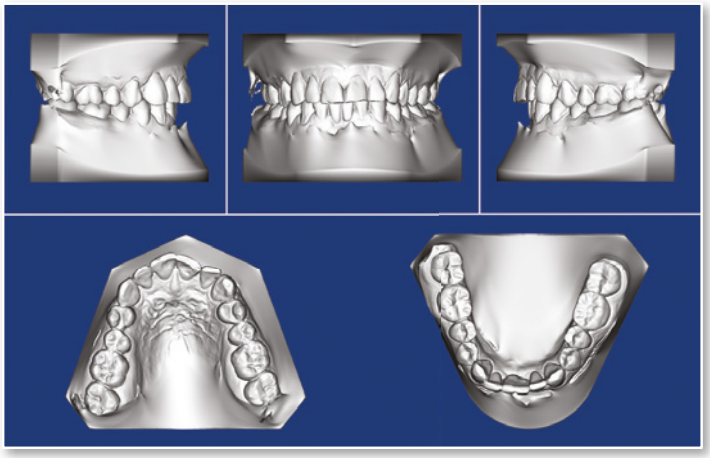
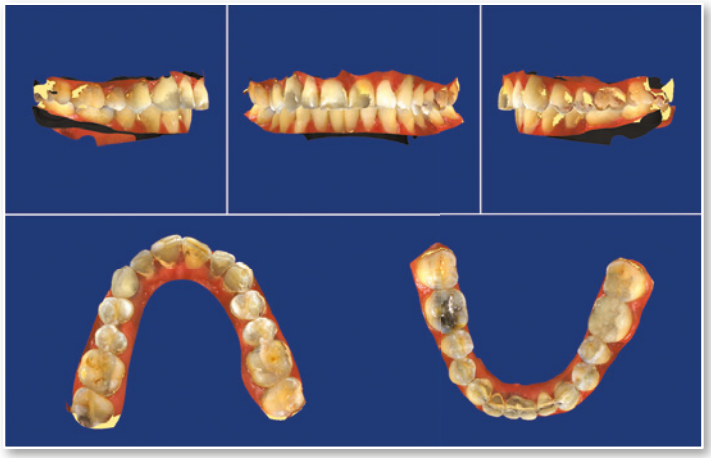


5-up model view



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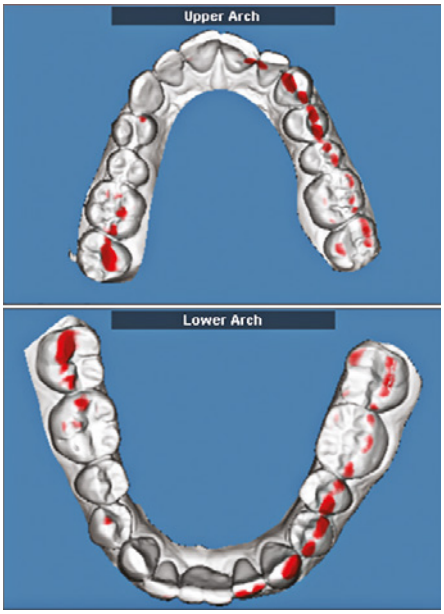

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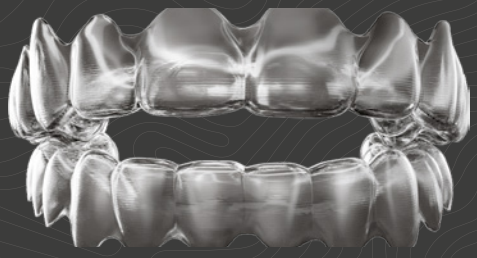

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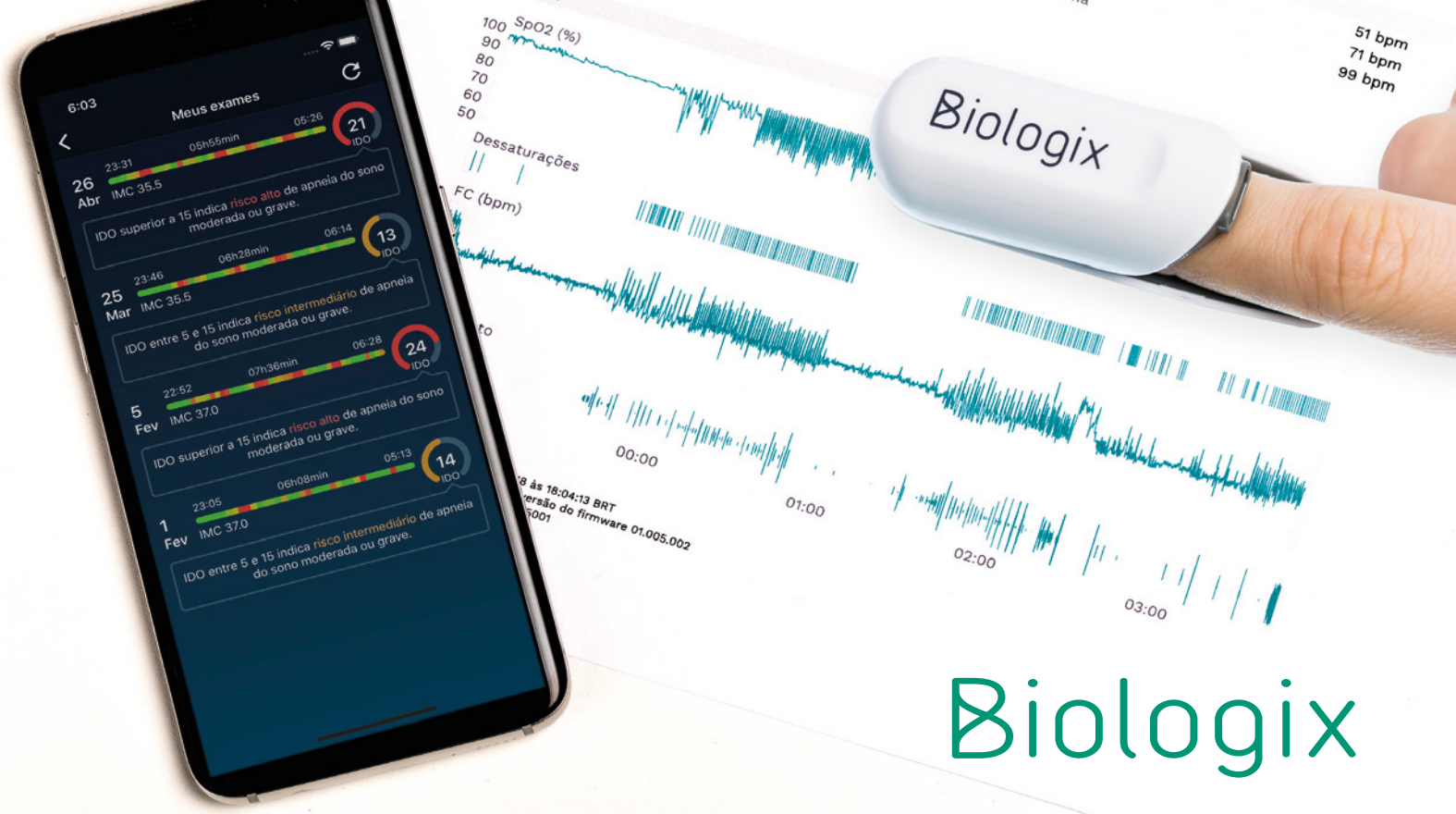

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Matheus Melo **Pithon**[1,2]

THE USE OF ANALGESICS INTERFERE IN THE ORTHODONTIC MOVEMENT

Orthodontic patients often describe an feeling of discomfort or pain associated with certain orthodontic procedures, such as placing elastic separators, replacement of orthodontic archwires and activation of appliances. Because of this, the use of painkillers by patients is not novelty. However, since such drugs can affect the biochemical process involved in the orthodontic dental movement, a comprehensive understanding of its effects is necessary. There is an infinity of studies that evaluated the interaction between movement orthodontic and analgesics; however, this is a topic that still lacks consensus. For this reason, Arab researchers developed a systematic review[1] that aimed at investigating, in animal studies, the quality of latest available evidence on the effect of painkillers in the rate of tooth movement. The results of this study revealed that the use of specific painkillers by few days can influence the speed of orthodontic dental movement . The authors point out that orthodontists should be aware of the implications of using these substances, and be able to identify those substances that may or may not interfere with orthodontic treatment.

ALOE VERA GEL PREVENTS TRAUMATIC ULCERS IN ORTHODONTIC PATIENTS

Traumatic mouth ulceration is one of the most common side effects of orthodontic treatments (Fig. 1). After installation of the orthodontic appliance, it is not unusual patients complaining of discomfort caused by traumatic injuries, erroneously called canker sores. Develop a product that prevents or minimizes such problems is among the wishes of the scientific community. Following this trend, Spanish researchers developed a randomized controlled clinical trial[2] that compared efficacy clinic of an 80% *Aloe vera* gel and a 0.12% chlorhexidine gel for the prevention of traumatic ulcers in users of fixed orthodontic appliances. Patients with 12 years or older, with permanent dentition and about to start orthodontic treatment were randomly allocated to use *Aloe vera* or chlorhexidine gel. Evaluations were made at pre-treatment and 1 month after installation of orthodontic appliance. The study results revealed that the administration of *Aloe vera* gel in patients with orthodontic appliances effectively prevents the appearance of traumatic ulcers in the mouth.

FIXED RETAINERS DO NOT REPRESENT RISK TO PERIODONTAL HEALTH

The etiology of post-treatment recurrence is complex and multifactorial; factors such as tension of the periodontal fibers, final occlusion obtained, soft tissue pressure, growth and aging are the most commonly described. Because of this, the need to retain teeth after orthodontic treatment completion is a consensus. It is known, nowadays, that to maintain teeth well aligned for life it is necessary to permanently use retainers, especially when it comes to the mandibular arch. However, doubts arise about how harmful to periodontal tissues may be the presence of retainers in the long run. To answer this question, Swiss and Greek researchers developed a review systematic review of the literature[3] in which they evaluated the databases Medline, EMBASE, Cochrane Oral Health Group's Trials Register, CENTRAL, ClinicalTrials.gov, National Research Register, Pro-Quest Dissertation Abstracts and Thesis. The authors were able to conclude that fixed retainers are devices compatible with periodontal health and do

Figure 1 - Typical presentation of traumatic ulcer after bonding of orthodontic band with bracket. Source: Leiva-Cala et al.[2], 2020.

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not cause serious harmful effects to the periodontium. However, the authors emphasize the need for further methodologically well executed clinical trials, comparing different types of fixed retainers after long periods of follow-up, so that definitive conclusions can be reached about the topic.

FIXED APPLIANCE PRESENTS BETTER COST-BENEFIT IN TREATING THE ANTERIOR CROSSBITE IN CHILDREN

Anterior crossbite is a prevalent problem in the child population. Its presence may be associated with a series of complications, such as gingival recession, mobility and TMJ disorders, as well as dental and facials disharmonies. Therefore, it is highly recommended to correct it as soon as possible, to allow for a normal development of occlusion and jaws. Until now, various treatment modalities have been proposed to correct the anterior crossbite, but none was based in high-quality evidence. With the propose to fill this gap, Arab researchers developed a systematic literature review[4] in order to investigate the effectiveness of the upper removable appliance in treating anterior crossbite, in terms of quality of life, effectiveness, treatment time, long-term stability and cost. For this, a search was carried out in the databases Cochrane Central Register of Controlled Trials (CENTRAL), PubMed, ScienceDirect, Scopus and Ebsco. All potential articles were independently checked regarding inclusion criteria. The risk of bias of studies eligible to be included in the analysis was evaluated by two authors, independently, using the Cochrane risk of bias tool. The authors concluded that the fixed appliance proved to be more economical in anterior crossbite correction than the removable appliance. There was no significant difference between the two appliances regarding quality of life, pain intensity or long-term stability.

THERE ARE NO EVIDENCES THAT PROVE THE EFFECTIVENESS OF DENTAL WHITENING AS THERAPEUTIC TO RELAX AND/OR TREAT WHITE-SPOT LESIONS

The presence of orthodontic accessories directly attached to the dental surface promotes the accumulation of dental biofilm. The presence of biofilm for a long time leads to the appearance of white-spot lesions. The white-spots lesions are common and undesirable side effects in patients using fixed orthodontic appliance and with poor oral hygiene. Resolving this problem includes from microabrasion to restoration of the compromised area. In recent years, another modality of treatment has been suggested, that is, masking — that would be the performance of tooth whitening with the proposal of masking white-spot lesions. However, there is, to date, no strong evidence to validate this therapy. Therefore, Greek and Danish researchers developed a study[5] that aimed to evaluate the literature, looking for evidence of the efficacy of whitening as a method to treat or soften enamel white spots after orthodontic treatment on permanent teeth. To this end, search strategies were created for different types of studies, including clinical trials randomized or nonrandomized, prospective and retrospective studies, as well as *in vitro* studies. The authors concluded that there is insufficient strong evidence to support or contraindicate whitening as an effective method for treating white spot lesions. The authors point out that most studies in this area is *in vitro*, thus requiring further prospective *in vivo* studies.

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A contraindication to orthodontic and endodontic treatment: periapical cemento-osseous dysplasia

Alberto **Consolaro**[1,2], Omar **Hadaya**[3], Renata Bianco **Consolaro**[4]

DOI: *https://doi.org/10.1590/2177-6709.25.5.017-022.oin*

Introduction: The dental pulp is completely normal in teeth with periapical cemento-osseous dysplasia. However, orthodontic and endodontic treatments are contraindicated in cases with this injury. **Objective:** Present some biological, clinical and imaging reasons opposing these contraindications and questioning which are the real ones impediments and the reasons for the lack of research on the disease, analyzing cases submitted to orthopedic treatment under controlled and ethically approved conditions. **Conclusion:** The clinician can act safely based in available knowledge and aware of the possible consequences of orthodontic movement in teeth with periapical cemento-osseous dysplasia, as well as in the proper way of making a safe and definitive diagnosis.

Keywords: Periapical cemento-osseous dysplasia. Orthodontic contraindications. Endodontic contraindications. Pulp vitality. Tooth movement.

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

Orthodontists should, also, have a general knowledge of clinical practice, which includes recognizing normal structures and those that have small and large extra- and intraosseous lesions.

The term "lesion" means any permanent or transient anatomical change that requires a diagnosis. Orthodontist are not required to make an accurate clinical and imaging diagnosis, but they should be able to see that something is not right and seek the support of specialists in oral and maxillofacial lesions, such as stomatologists, oral pathologists and oral and maxillofacial surgeons.

In the few cases in which orthodontic treatment is contraindicated, very often the patient has inherent biological limitations, and there are no technical limitations of the orthodontic specialty.[1] Patients should receive a detailed explanation, based on solid data and demonstrations of the consequences of orthodontic treatment if it is conducted in spite of these contraindications.

In these cases, the communication of the orthodontist and the other specialist with the patient and his family should be repeated and explained thoroughly to avoid being affected by ignorance and equivocal information that may be received later from other people and professional, which may make patients and families feel insecure. Easy and immediate access should also be made available at this point so that they may talk about the insecurity and questions that may emerge when making these decisions.

Two clinical situations motivated us to present this paper to specialists in Orthodontics:

1) Cases of periapical cemento-osseous dysplasia in patients with endodontically treated teeth are not rare.

2) The frequency of patients with periapical cemento-osseous dysplasia undergoing orthodontic treatment has been growing. Imaging diagnoses of these cases are eventually made using periapical radiographs or CT scans to investigate why mandibular anterior teeth are not moving as expected during the progression of the treatment.

WHY NOT MOVE TEETH ORTHODONTICALLY OR TREAT THEM ENDODONTICALLY IN CASES OF PERIAPICAL CEMENTO-OSSEOUS DYSPLASIA?

Teeth with periapical cemento-osseous dysplasia have a normal fully formed pulp and no inflammation or early ageing, let alone calcific metamorphosis, metaplasia of the pulp, or aseptic pulp necrosis.

In periapical cemento-osseous dysplasia, osteoblasts, clasts or both initiate the replacement of local bone with a cellularized connective tissue in the periapical region, which slowly produces a new mineralized tissue in the place, grossly similar to tooth cement. Its cause remains unknown and, although it is expected to originate in a genetic abnormality, the chromosome and gene affected have not been determined. There is no biological explanation to why it occurs so often and is limited to the alveolar bone in this region.

Mineralized tissue produced by newly formed cellularized connective tissue in cases of periapical cemento-osseous dysplasia is disorganized, little mineralized and does not reorganize the region so that the alveolar periapical structures are reconstructed, and leaves them without a lamina dura or trabecular bone and, especially, no periodontal ligament.

As self-limiting bone resorption and replacement of an average of 1 cm in diameter from the tooth apex, newly formed cellular fibrous tissue does not take up pulp space or compress the vessels that supply the dental pulp. In other words, there is no inflammation or pulp necrosis.

As it fills the periapical space, the newly mineralized tissue gradually approximates normal cement and merge with it, displacing cementoblasts to neighboring areas, establishing continuity with the tooth (Figs 1 and 2). A precise detection of what was a lesion and what was a tooth becomes impossible in the intermediate and advanced phases of periapical cemento-osseous dysplasia.

Resorption "respects" and does not involve apical dental tissues, only the tissues of the periodontal ligament and bone (Figs 1 and 2). The reason why these dental structures are preserved is unknown, but tissue section under microscopy do not show any local cementoblast or odontoblast necrosis. These cells —cementoblasts and odontoblasts— do not have receptors for bone remodeling mediators, and are not genetically anomalous in the process in which only periapical alveolar osteoblasts are involved.

Along time, there is no replacement of apical dental tissues with newly formed tissue produced during periapical cemento-osseous dysplasia, which would characterize replacement resorption. Newly formed tissue combines or continues the tooth structures, but with no tooth resorption or replacement.

Orthodontic treatments should not be conducted because, once periapical cemento-osseous dysplasia is established, cellularized connective tissue replaces the periodontal ligament and produces islands and trabeculae of newly formed mineralized tissue, very similar to cementum, but disorganized. The essential tissue for tooth movement in orthodontic treatment is the periodontal ligament,[1] where osteoclasts, new cementoblasts and osteoblasts circulate. This ensures that, after each appliance activation, alveolar tissues, including apical cementum, ligament and alveolar bone reorganize and prepare for a new movement cycle to start immediately after that.

The newly mineralized tissue thus produced unites with the tooth, and, as there is no periodontal ligament, tooth movement is impossible. However, we may ask ourselves: before any mineralized tissue is seen on CT scans and radiographs, would it be possible to move teeth that have periapical cemento-osseous dysplasia lesions that still appear fully radiolucent?

We may say that, yes, it is physically possible, but tooth movement is not a physical event, but, rather, a biological event mediated by cells and chemicals.[1] Minor movements may be possible, but not to achieve substantial changes in the position of the teeth involved. If periapical cemento-osseous dysplasia is at its intermediate or final stage, mineralized tissue will already be united and fused with the tooth, and tooth movements will be impossible.

In sciences, including biology and medicine, there are no moments in which we should use the words

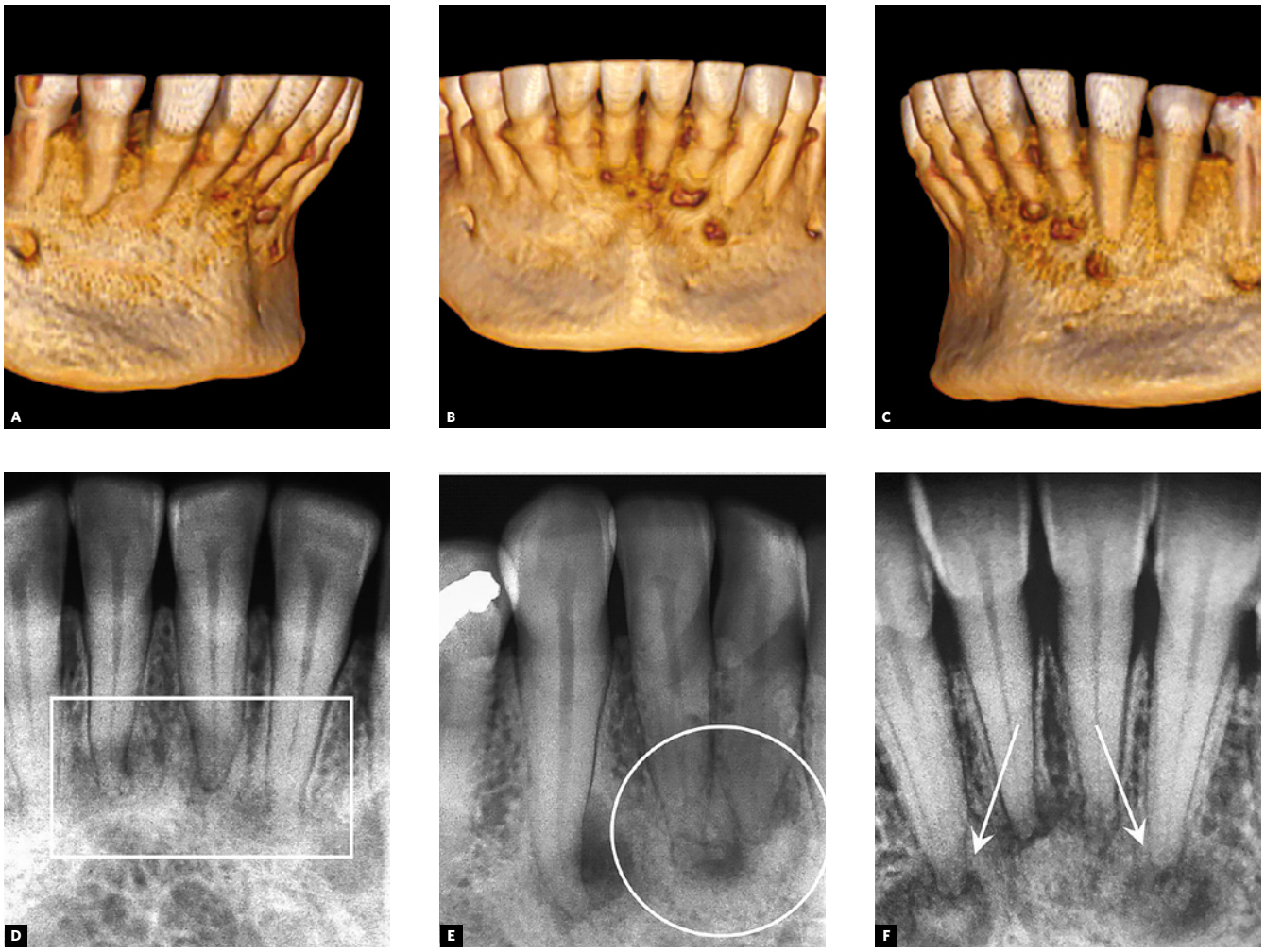

Figure 1 - A, B, C) 3D reconstruction of CT sections of mandibular incisors and canines in patient with intermediate-stage periapical cemento-osseous dysplasia. First periapical radiograph (**D**) of another patient at initial stage: newly-formed mineralized and cementoid tissue has not been deposited or mineralized. Second image (**E**) shows denser mineralized areas still separated from apex (circle). Third image (**F**) shows mineralized tissue randomly continuous with apex (arrows).

"always" or "never"! Even in the initial stage, and still in the intermediate and final stages, there are no reports of cases of application of orthodontic forces to teeth with periapical cemento-osseous dysplasia in controlled and ethically approved study protocols to evaluate this treatment alternative.

ASPECTS AND TREATMENT OF PERIAPICAL CEMENTO-OSSEOUS DYSPLASIA

1) Periapical cemento-osseous dysplasia is not a neoplasia; it is, rather, characterized by a pseudotumoral fibro-osseous lesion without a history of becoming malignant[2]. However, some authors[2] found that it may be an initial form of florid cemento-osseous dysplasia. In these cases, the risk of this condition should be evaluated thoroughly, and one way to do this is to carefully examine all the mandibular bone to detect initial radiolucent areas.

2) A diagnosis of periapical cemento-osseous dysplasia is more common in black women of about 40 years of age, and this should be taken into consideration. In younger patients, cases are usually diagnosed at its initial, or radiolucent, stage, and it may affect one or more incisors too! In this stage and condition, patients may equivocally receive a wrong diagnosis and an indication of endodontic treatment, even though pulp vitality is detected. An endodontic treatment may lead to contamination of the area and extravasation of material without any beneficial effects for the progression of the disease, and should, therefore, be avoided in all cases.

3) If the teeth affected by this disease also have caries or periodontal disease, they should be treated as usual for these conditions, considering that the pulp is vital and only the periodontal ligament is affected. If there is pulp necrosis for any other reason, more often because of advanced caries or, also, dental trauma, the endodontic treatment is necessary and should follow the usual criteria for it.

4) Some possibilities are raised — and maybe even adopted — such as endodontic surgery including the apex of all incisors, removed using curettage, or the full removal of apical thirds and periapical alveolar bone, as the lesion is encapsulated. There are no cases in the literature that describe the benefits a patient would have, but if endodontic surgery repairs the lesion, would it be possible to move teeth orthodontically? In theory, considering what we know about the orthodontic treatment of teeth that underwent endodontic surgery, but before we do it, controlled and ethically approved studies should be conducted to evaluate this option for the treatment of periapical cemento-osseous dysplasia.

WHAT WOULD BE THE CONSEQUENCES OF MOVING TEETH WITH PERIAPICAL CEMENTO-OSSEOUS DYSPLASIA?

1) Will there be more tooth resorptions in these patients? We do not know that, but the distribution of forces on the roots and alveolar bone becomes random and out of the control of the orthodontist.

2) Is there any risk of pulp necrosis in these teeth? Probably no, but there are no data to confirm this hypothesis.

3) Is there any, no matter how slight, chance of this type of lesion becoming malignant? No, periapical cemento-osseous dysplasia is a change of cell function, and not a cell proliferation disorder.

4) Is there any chance of microbial contamination in the area? Also no, because the biological process of moving teeth does not contaminates tooth tissues.

5) Is there more pain and discomfort for the patient during orthodontic treatment? Maybe yes, because the biological process of movement becomes random and may generate mediators of inflammation and pain!

6) Are buccal and lingual bone losses probable? It is impossible to predict that, but tooth movement, as well as the distribution of forces, becomes random.

7) Would there be a greater chance of periapical cemento-osseous dysplasia progressing into florid cemento-osseous dysplasia because of tooth movements? It is impossible to know without any studies about it.

HOW TO MAKE A SAFE AND DEFINITIVE DIAGNOSIS OF PERIAPICAL CEMENTO-OSSEOUS DYSPLASIA?

Tooth and periodontal changes should not be diagnosed based on panoramic radiographs, because they have several distortions and superimpositions that may lead to false positive or false negative results. Even more important is that this diagnosis of dental and periodontal changes should not be made in the anterior area of the maxilla and mandible.

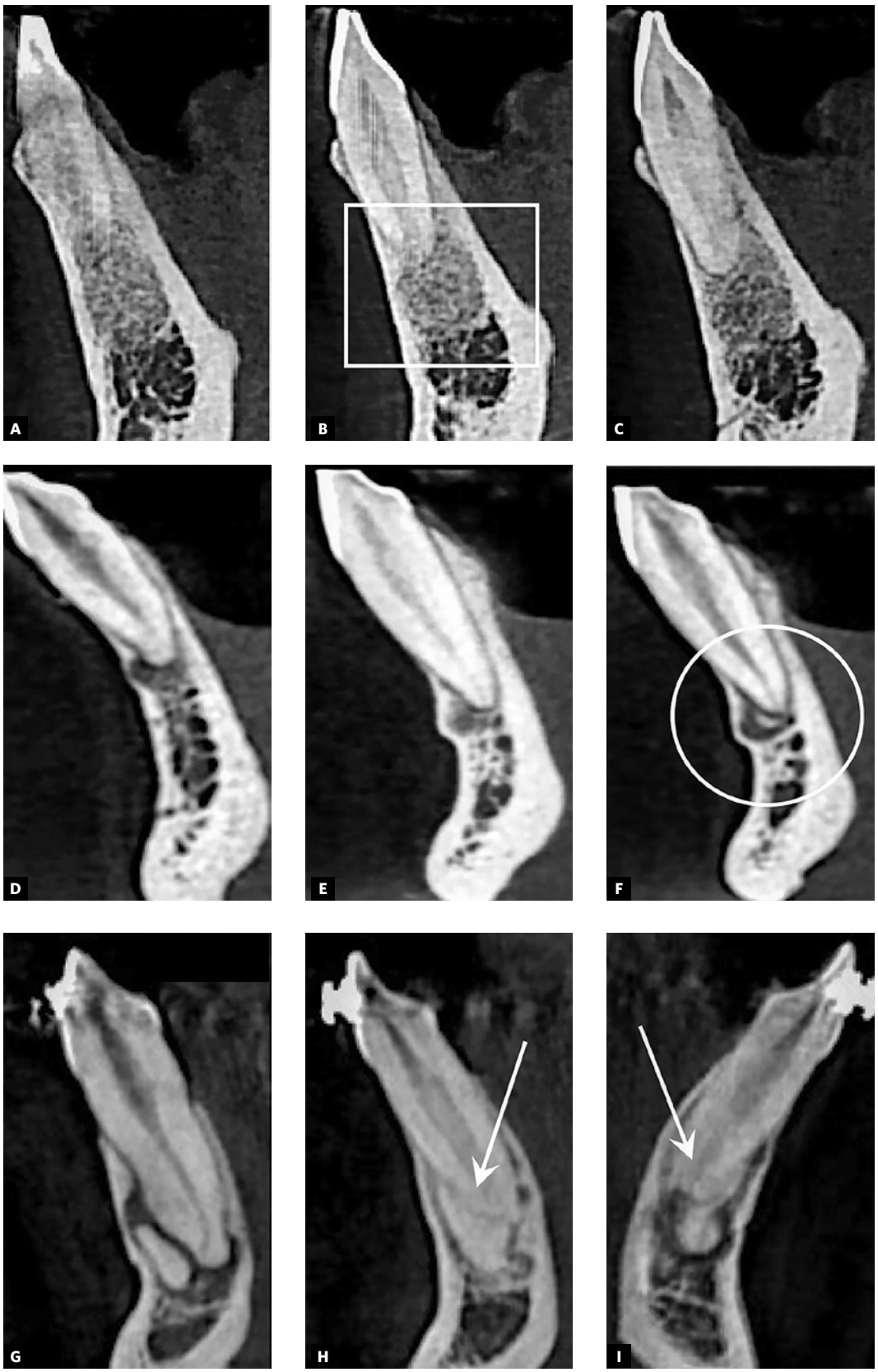

Figure 2 - CT sections (lateral/sagittal view) of mandibular incisors of three patients with periapical cemento-osseous dysplasia. In first group of images (**A, B, C**), disease is at initial stage; newly-formed mineralized and cementoid tissue has not been deposited or mineralized, which generates irregular hypodense area mottled with delicate hyperdense dots (box). In second group (**D, E, F**), densely mineralized area is still separated from apex (circle). In third group (**G, H, I**), mineralized tissue fuses with tooth and is randomly continuous with tooth structure (arrows).

Several cases of periapical cemento-osseous dysplasia are not visualized on panoramic radiograph, particularly, in its initial stage, when the lesion is still radiolucent This disease affects mandibular incisors in particular, and may extend to canines and, rarely, to premolars.

In several cases, periapical cemento-osseous dysplasia is diagnosed during orthodontic treatment, because it began before the ideal conditions had been ensured: periapical radiographs of all teeth obtained before and after orthodontic treatment. If only panoramic radiographs are obtained for planning and treating orthodontic cases, the diagnosis of some changes, such as tooth resorptions, caries and periodontal disease, may be missed.

Periapical cemento-osseous dysplasia during orthodontic treatment planned without periapical radiographs are eventually diagnosed because the anterior teeth do not move, in spite of the application of forces. To investigate it, CT scans or periapical radiographs are obtained when periapical cemento-osseous dysplasia is detected, now already in its intermediate stage.

The diagnosis of periapical cemento-osseous dysplasia is made based on clinical and imaging findings, and microscopic evaluations are not necessary, as the images and signs and symptoms are unique and characteristic of this disease, ensuring a safe diagnosis. No biopsy is necessary.[2] CT scans provide a reconstruction and three-dimensional assessment of the condition at a certain moment (Figs 1 and 2). As years go by, the mass of irregular mineralized tissue is hyperdense, if continuous to teeth, are separated from bone by an irregular and imprecise hypodense or radiolucent halo on radiographs.

Another factor to be taken into account in the diagnosis of periapical cemento-osseous dysplasia is the patient's profile, as most are black women in their forties. Ethnicity interacts closely with periapical cemento-osseous dysplasia, a disease that probably results from a genetic defect that induces it. In Brazil, 75% of the people have genes of this ethnicity, as the level of mixed ethnicity is high among the Brazilian population. Therefore, patients, even men, that seem to be white and have a Caucasian profile may present with this disease.

FINAL CONSIDERATIONS

Before controlled, ethically approved studies with patients with periapical cemento-osseous dysplasia are conducted, these patients should not undergo orthodontic treatments, as safe results and precise risk of damages cannot be predicted. Individual clinical attempts to treat these patients orthodontically may be laudable in that it is a sign of the desire to do it right for our patients. However, they may be ethically and legally questionable, as there is no scientific basis derived from methods applied in controlled studies including series of cases of periapical cemento-osseous dysplasia.

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Factors associated to quality of life of orthodontists graduated from a public university (1993-2016): A mixed-methods approach

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Introduction: For dental professionals, including orthodontists, Quality of life (QOL) is a topic of growing concern and could be determined by objective and subjective complex factors.

Objective: This study analyzed the factors that influence the QOL of orthodontists graduated between 1993 and 2016 of a public university (Medellín, Colombia).

Methods: A mixed-methods study was conducted (cross-sectional survey; 88 participants; 3 focus groups, 21 participants). Quantitative analysis: the research included sociodemographic, labor and health characteristics as independent variables and the WHOQOL-BREF questionnaire as main outcome for QOL. Frequencies were calculated and the association between QOL and independent variables was estimated by bivariate analysis (Chi square tests) and a linear multivariate regression. Qualitative analysis: Narrative content analysis according to thematic categories. Mixed methods: a conceptual framework for QOL using the triangulation was developed.

Results: All the scores surpassed 55 points on the 4 domains of WHOQOL-BREF. A lower value was found in the physical dimension (57.1±10.7) and a greater value in the psychological dimension (70.8±8.3). The variables associated positively to QOL were permanent contract, teaching/research activities, monthly income, resting days per week and sex. Factors associated negatively were low social support, mental health and rent housing. Discourses of participants allowed to identify the concept of QOL and the contextual and social determinants and satisfiers.

Conclusion: QOL of orthodontists is influenced by sociodemographic, employment, working and health factors. Therefore, QOL is a multidimensional concept that recognizes the political and socio-economic context and personal and professional experiences.

Keywords: Quality of life. Orthodontists. Health surveys. Dental research. Qualitative research.

*** Access www.scielo.br/dpjo to read the full article.**

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Lateral and apical root resorption in teeth orthodontically moved into edentulous ridge areas

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Objective: The present study aimed at comparing the external lateral root resorption (ELRR) and external apical root resorption (EARR) between teeth moved through the atrophic edentulous ridge and those undergoing the usual orthodontic movement.

Methods: Fifty-four premolars were evaluated, where 27 of them had been moved toward the edentulous ridge (Group 1) and 27 from the same patient, had not been translated, which comprised the control group (Group 2). ELRR was evaluated by 0-3 scores and EARR was evaluated by 0-4 scores, before and after movement. Measurements were compared by Kruskal-Wallis and Student-Newman-Keuls tests.

Results: ELRR increased statistically only in the Group 1 ($p < 0.05$). After orthodontic treatment, it was observed that almost 56% (n = 15) of teeth in Group 1 presented scores 2 and 3, while Group 2 presented scores 2 and 3 in about 11% (n= 3) of the teeth. EARR increased in both groups after orthodontic movement, however, statistically analyses showed no significant differences between groups ($p > 0.05$).

Conclusions: Orthodontic movement into the atrophic edentulous ridge is subject to a greater lateral external root resorption.

Keywords: Tooth movement. External root resorption. Edentulous alveolar ridge.

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INTRODUCTION

After a tooth is extracted, a dimensional reduction of the alveolar bone occurs. One year later, it can reduce to an average of 50%.[1] Such dimensional loss is more pronounced on the buccal than on the lingual side of the alveolus, and makes implant placement difficult.[2] Among the various procedures for improvement of the alveolar ridge, there are several types of grafting surgeries, lateralization and transposition of the inferior alveolar nerve. However, they can be considered invasive and/or expensive. In addition, vertical stability of the grafts, in general, presents poor predictability.[3] In this context, the use of orthodontic movement becomes an interesting alternative to restore the dimensions of the atrophic ridge, optimizing the relationship between the adjacent hard and soft tissues.[4-7]

To have proper preservation of the alveolar bone as well as root integrity, the movement must take place in the absence of plaque, which can promote additional inflammation.[8,9] The force used should also maintain a physiological level, since excessively heavy forces can result in significant root resorption.[10-12] Although mild root resorption is considered inherent to orthodontic movement,[13-15] the advancement in knowledge of the effects of root architecture and different orthodontic therapies can help reduce the magnitude of the deleterious effects. Although the literature has extensively explored external root resorption in conventional orthodontic treatments,[13-19] root response when a tooth is moved towards an atrophic ridge is less studied, especially in regards to lateral root resorption.[7]

Given this, the present study aims to compare the external lateral root resorption (ELRR) and external apical root resorption (EARR) between teeth moved through the atrophic edentulous ridge and those undergoing usual orthodontic movement. The null hypothesis tested was that external root resorption is similar in both groups.

MATERIAL AND METHODS

This retrospective study was approved by the Human Research and Ethics Committee of the University of Maringá (UEM) (CAAE #0045.0.093.000-11). All patients authorized the use of their records. The sample size was calculated considering a test power of 0.8, alpha of 0.05, with a desired difference of 1, as well as a variation of 1 for the score for each patient. Thus, the sample size should be 18 teeth for each group.

Radiographic records of 22 patients (8 males and 14 females) were evaluated: individuals who had lost at least one first molar (for more than 2 years), with subsequent atrophy of the alveolar bone that prevented the installation of dental implants. Mean age of the sample was 46.22 years old (SD = 8.41), ranging from 31.3 to 47 years old. Patients with systemic diseases, active periodontal disease and/or smoking habit were excluded. Previous orthodontic treatment and graft surgery were also exclusion criteria. Five patients had bilateral atrophic regions, and 17 had unilateral ones. A total of 27 premolars were moved through the atrophic alveolar ridge, composing the experimental group (Group 1), and 27 premolars submitted to conventional orthodontic movement, in the same patients, comprised the control group (Group 2).

Before and after orthodontic movement images taken from patients' radiographic records were used. They comprised parasagittal slices from cone-beam computer tomography (CBCT) (16 premolars, from 12 patients), periapical (6 premolars, from 6 patients) and panoramic (5 premolars, from 3 patients). All patients received conventional alignment and leveling orthodontic treatment, starting with 0.014-in NiTi archwire, followed by 0.016-in, 0.018-in and 0.020-in stainless steel archwires (Morelli®, SP, Brazil). The movement through the atrophic ridge was carried out with NiTi open coil springs inserted on 0.020-in steel archwire and on subsequent 0.019 x 0.025-in steel archwire in 0.022-in brackets (Abzil-3M®, SP, Brazil). Mean orthodontic treatment time was 17.15 months (SD = 6.08), ranging from 8.5 to 30.3 months. The mean movement through atrophic area was 5.98 mm (SD = 1.36), minimum 4.5 mm and maximum 10.2 mm. Ten mandibular left second premolars, 11 mandibular right second premolars, 2 mandibular left first premolars, 1 mandibular right first premolars, 2 maxillary left first premolars and 1 maxillary right first premolar were moved through adjacent atrophic alveolar bone. Control tooth in unilateral case was its homologous tooth on the other side (5 mandibular right second premolars, 6 mandibular left second premolars, 2 mandibular right first premolars, 1 mandibular left first premo-

lar, 2 maxillary right first premolars and 1 maxillary left first premolar), and in bilateral sites the adjacent premolar —not moved into the atrophic bone— was evaluated (5 lower right first premolars and 5 lower left first premolars). Control teeth were anatomically similar to the experimental group.

ELRR was evaluated before and after orthodontic treatment in radiographic records, according to the following scores from 0 to 3: 0 = absence of resorption; 1 = presence of slight resorption lacunae; 2 = presence of a clear resorption lacunae; 3 = presence of more than one distinct resorption lacunae and/or clear reduction in root thickness (Fig. 1).

As a secondary outcome, the EARR was also assessed, before and after orthodontic treatment, following the Levander and Malmgren[13] method. The scores of 0 to 4 were attributed according to the following classification: 0 = absence of resorption; 1 = mild resorption, irregular apical contour; 2 = moderate resorption, small root loss, with the apex displaying a partially straight contour; 3 = marked resorption, loss of almost ⅓ of the root length; 4 = extreme resorption with loss of more than ⅓ of the root length (Fig. 2).

Statistical analysis

Two calibrated examiners performed evaluations. Measurements were repeated for all the images after an interval of 30 days. The agreement was checked by Kappa weighted test. External root resorption scores were compared by Kruskal-Wallis, followed by Student-Newman-Keuls post-test, using BioEstat 5.0 software (Instituto Mamirauá, AM, Brazil).

RESULTS

Kappa tests showed good agreement between the two moments of evaluation for lateral scores (examiner 1 = 0.82; examiner 2 = 0.80), as for apical scores (examiner 1 = 0.79; examiner 2 = 0.81). Inter-examiner Kappa tests also showed good agreement (0.81 for lateral scores and 0.83 for apical scores). Medians of scores between the two examiners were used for statistic comparisons.

In Kruskal-Wallis/ Student-Newman-Keuls comparison between before and after treatment, ELRR increased statistically only in the Group 1 (Table 1). The teeth moved over the ridge had higher lateral resorption scores. After orthodontic treatment, it was observed that almost 56% (n = 15) of the teeth in Group 1 presented scores 2 and 3 (2 = presence of a clear resorption lacunae; 3 = presence of more than one distinct resorption lacunae and/or clear reduction in root thickness), while Group 2 presented those scores in about 11% (n = 3) of the teeth (Fig. 3).

EARR increased in both groups after orthodontic movement (Table 2), however, statistical analyses showed no significant differences between groups ($p > 0.05$). The EARR scores distribution is shown in Figure 4.

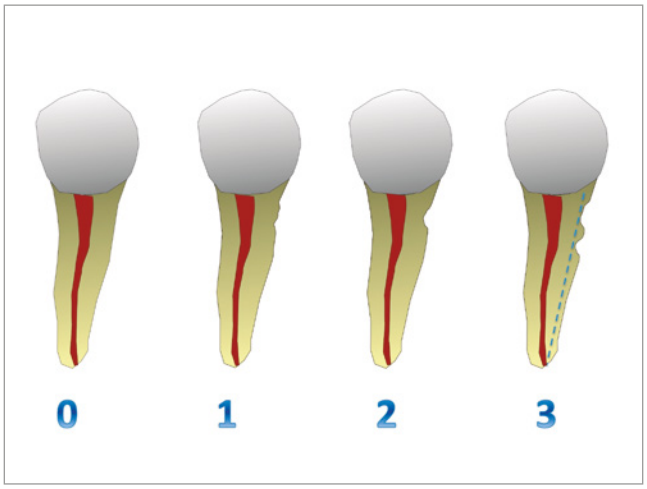

Figure 1 - Classification of lateral root resorption: 0 = absence of resorption; 1 = presence of slight resorption lacunae; 2 = presence of a distinct resorption lacunae; 3 = presence of more than one distinct resorption lacunae and/or clear reduction in root thickness.

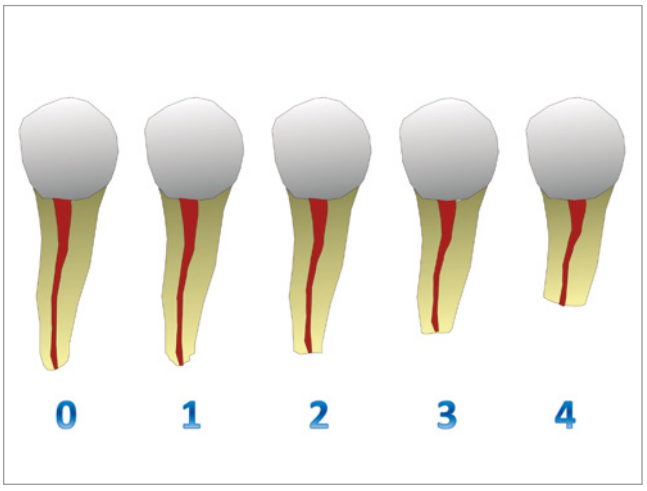

Figure 2 - Classification of apical root resorption: 0 = absence of resorption; 1 = mild resorption, irregular apical contour; 2 = moderate resorption, small root loss, with the apex displaying an almost straight contour; 3 = marked resorption, loss of almost ⅓ of the root length; 4 = extreme resorption with loss of more than ⅓ of the root length (Source: modified from Levander and Malmgren[13]).

Table 1 - Median, 1st quartile and mean scores of the ELRR and Kruskal-Wallis/ Student-Newman-Keuls comparisons.

	Group 1		Group 2	
	Before	After	Before	After
Median (1st – 3rd quartiles)	0 (0-1)[a]	2 (1-3)[b]	0 (0-0.5)[a]	0 (0-0.5)[a]

Different superscript letters represent statistical significance at $p < 0.05$.

Table 2 - Median, 1st and 3rd quartiles scores of the EARR and Kruskal-Wallis/ Student-Newman-Keuls comparisons.

	Group 1		Group 2	
	Before	After	Before	After
Median (1st – 3rd quartiles)	1 (0-1)[a]	1 (1-2)[b]	0 (0-1)[a]	1 (0-1)[b]

Different superscript letters represent statistical significance at $p < 0.05$.

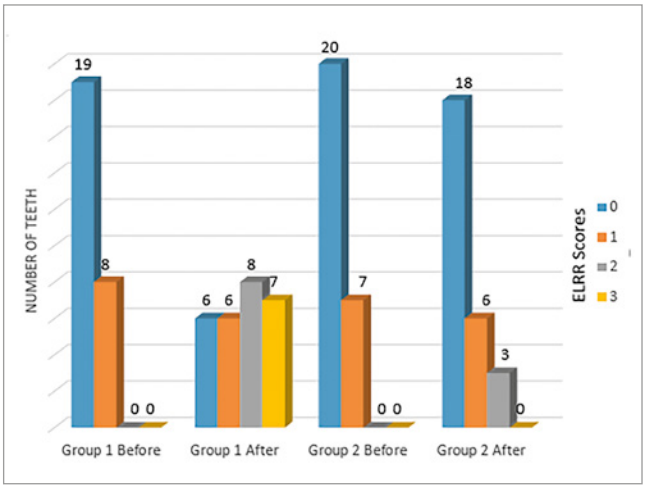

Figure 3 - Distribution of teeth in scores related to lateral root resorption (ELRR) before and after orthodontic treatment.

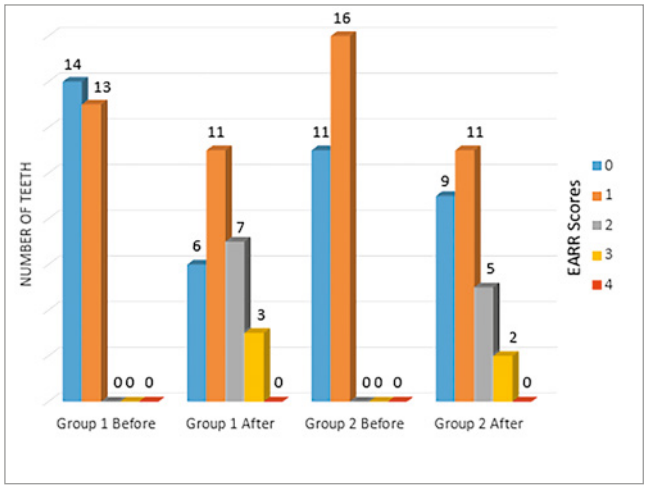

Figure 4 - Distribution of teeth in the scores related to apical root resorption (EARR) before and after orthodontic treatment.

DISCUSSION

The tooth movement over the atrophic ridge have been demonstrated to be an alternative treatment approach for formation of alveolar bone through the transfer path,[8] allowing better condition for implant placement.[4-7] Besides its advantages, this movement has been less investigated regarding root resorption, mainly the ELRR, that is a less common side-effect during a conventional orthodontic treatment.[7]

In the present study, the null hypothesis should be partially rejected, once the EARR scores were similar in teeth moved through the atrophic edentulous ridge comparing to controls. However, ELRR scores were significantly different in Group 1. It is important to emphasize that none of the teeth in both groups showed periodontal or endodontic commitment during or after orthodontic movement.

After movement through atrophic ridge, Group 1 showed scores 2 or 3 in almost 56% (n=15) of the teeth, while the Group 2 presented those scores in about 11% (n=3). Similar findings were shown by Diedrich et al,[9] who reported 40.6% of the 32 premolars moved through the atrophic bone. Lindskog-Stokland et al.[7] reported that some lateral root resorption is an inevitable occurrence after such orthodontic movement.

After an extraction, a dimensional reduction of the alveolar bone occurs. One year later, it can reduce to an average of 50%,[1] and the width reduction is greater than the loss of height.[20] The high risk for ELRR may be correlated to the proximity of buccal and lingual cortical plates in edentulous alveolar ridge, as more periodontal stress during tooth movement can be generated in such a dense bone.[21]

EARR is a well-known side effect of the orthodontic treatment, and the second outcome of the present study confirms that. Both groups presented similar scores of EARR, which are also in agreement with previous studies.[7,9] As the apex is far from the cortical plates, this could explain why root responses were similar for both groups. Despite the risk to occur, either EARR and ELRR appear to cease after treatment.[6,7,10,13] As such external root resorptions are inflammatory and induced by the orthodontic forces, no endodontic treatment is needed.[10]

It was reported that tooth movement for alveolar bone recovery can also be performed through the invaginations of the maxillary sinus.[22] If there is more cortical bone adjacent to the movement (invagination area), the reshaping will occur more slowly and the moved tooth possible will present more resorption.[23] In the present study, only 3 patients had premolars moved through maxillary sinus invagination. One of them presented score 3, one presented score 2, and the other one showed score 0, for ELRR after movement. Limitation of the number of maxillary teeth studied did not allow us to affirm precisely, but seems that the root response is similar to that in mandible, in agreement to Lindskog-Stokland et al.[7]

Imaging tests are essential for diagnosing and monitoring root resorption. If in the first 6 months of treatment noticeable external root resorption is diagnosed, the orthodontic treatment must be done in a slower pace.[10] CBCT allows for the analysis and visualization of images in full size.[14,15,17] However, due to the high cost and radiation exposure, it is less used in routine practice. Periapical and panoramic radiographs are more frequently used, and they proved to be a good diagnostic tool for external root resorption.[14,15] However, they present distortions that must be taken into account when performing metric ratings.[17] This study used qualitative scores that are less influenced by amplification issues. Levander and Malmgren[13] scores for EARR were created for periapical radiography evaluation, although they can be applied for any radiographic source. Scores are easy to apply, and they set clinically relevant thresholds of EARR diagnostic.[13] Similarly, in the present study, we developed scores for ELRR for the same reasons. Kappa tests showed similar intraexaminer and interexaminers agreement, both for EARR and ELRR evaluations. Despite this agreement, there were some limitations due to the different radiographic sources. However, this fact was minimized by using scores for the same tooth.

Clinically, it can be interpreted that the movement through the atrophic ridge is an advantageous strategy.[7,22,24-26] However, individual evaluation is critical for the treatment options on surgical graft or orthodontic-based bone rebuilding. Future studies with quantitative measurements are suggested using CBCT images.

CONCLUSION

Orthodontic movement in an atrophic edentulous ridge is subject to a greater risk of external lateral root resorption.

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The influence of text messages and anxiety on pain perception and its impact on orthodontic patients routine

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Objective: This prospective study aimed at assessing the effects of anxiety and a follow-up text message on pain perception after the installation of fixed orthodontic appliances and its impact on the patients' routine.

Methods: The sample of this study consisted of 103 orthodontic patients, 40 males and 63 females (mean age 20.5 years), distributed in two groups: G1 (n=51), including control patients that did not receive any post-procedure communication; and G2 (n=52), including patients that received a structured text message. In baseline phase, the patients completed a questionnaire to assess their level of anxiety prior to treatment. Pain was assessed by using 100-mm visual analog scale (VAS) in baseline and ten times prospectively in predetermined time points. VAS was also applied to assess the patient's routine alterations caused by the pain. All data were analyzed using ANOVA, Tukey, Mann-Whitney, *t*-test, chi-square and Spearman's correlation tests. All statistical tests were performed with significance level of 5%.

Results: Low-level and high-level anxiety was observed in 42.7% and 7.8% of the patients, respectively. Statistically significant correlation was observed between anxiety and pain ($p < 0.05$). Maximum mean pain intensity was detected in the second treatment day (G1=36.9mm and G2=26.2mm) and was significantly higher in G1. Nearly 53% of the patients in G1 reported alterations in the routine (18.8mm), while in G2 the percentage rate reached 28.8% (9.9mm) (p=0.013).

Conclusions: Anxious patients report more pain after the installation of orthodontic appliances. Text messages were effective to reduce pain levels and to decrease the negative effects on patients' daily routine.

Keywords: Orthodontics. Pain. Anxiety. Visual analogue scale.

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INTRODUCTION

Pain is usually experienced in the beginning of the orthodontic treatment.[1] Most of the pain reported is related to lesions in the oral mucosa due to local trauma. Moreover, orthodontic forces applied for tooth alignment also play an important role in promoting pain.[2] Usually, 91% of the orthodontic patients report discomfort, sensibility and pain during the installation of orthodontic appliances, while 39% report the same complaints after the orthodontic activation.[3] The highest levels of pain are manifested in the second and third treatment days. The pain may reduce progressively after a few days, but it can persist months after installation, especially when a new archwire is installed.[5]

Aside from the physical complaints, psychological aspects, such as cognition, socialization and personality[6,7] may also be affected by the increase in pain.[3] Among those, anxiety emerges as a key aspect.[6,8] Combined with anxiety, the increased perception of pain may hamper social and daily activities, especially eating and sleeping. Consequently, patients may respond by self-medicating[3] and perhaps asking to quit the orthodontic treatment.[8-11] This harmful combination could be attributed to specific dental stimuli that may trigger severe levels of anxiety that interfere with the orthodontic treatment.[12]

The search for strategies to reduce or eliminate anxiety in patients may contribute to decreasing their perception of pain.[13,14] Phone calls[13,15,16] and text messaging[8,17] during the treatment have demonstrated positive outcomes for controlling anxiety[6] and reducing the perception of pain.[8,13,17] It has been reported that after dentoalveolar surgery, most patients are satisfied with telephone follow-up, and it was suggested that this type of follow-up procedure should always be done, both in public and private health services[15,16]. Keith et al.[17] sent structured text messages to their patients explaining the potential alterations in routine and discomforts inherent to the orthodontic treatment. The authors observed that higher anxiety levels were detected within patients that did not receive the messages. Together with high anxiety, the patients also expressed higher perception of pain.

Despite the potential association between anxiety and the perception of pain, there is no study dedicated to validate the impact of those variables in the daily routine of patients — especially in the early stage of orthodontic treatment. In practice, the impact of pain perception on patient's motivation and compliance during the treatment is still unclear.

The present study aimed at assessing the association between pain and anxiety in young adult patients after the installation of fixed orthodontic appliances. The hypothesis that text messages could contribute to decrease the pain associated with orthodontic treatment and its impact on patients' daily routine was also investigated.

MATERIAL AND METHODS

This prospective study was performed after the approval of the Committee of Ethics in Research of *Centro Universitário Unisagrado* (CAAE 53269815.5.0000.5502). All the patients (or their legal guardians) signed an informed consent form to participate in the study.

The patients were recruited from private dental offices between January 2016 and April 2017. According to the inclusion criteria the patients should be aged 14-30 years old, have permanent dentition with malocclusion and moderate crowding — justifying orthodontic treatment with fixed appliances —, should have access to a smartphone, and good oral health condition. Additionally, the patients that were included in the study had complete orthodontic charts that consisted of clinical records, dental casts, panoramic and cephalometric radiographs, and intra- and extraoral photographs. The exclusion criteria consisted of previous orthodontic treatment, medical history of chronic diseases and chronic self-medication, especially anxiolytic drugs.

Power analysis was performed for sample size calculation with a significance level of 5% and test power of 80%. The standard deviation of 17.64 was adopted following the outcomes of Keith et al.[17] According to these findings, a sample of 50 subjects would be necessary in each study group to support a difference of 10mm in the Visual Analogue Scale (VAS). Based on the calculation, the sample size was set at 103 patients.

The sample was randomly divided into two groups. A computer-generated randomization list was created using Excel (2007, Microsoft Win-

dows). Group 1 (G1, control) consisted of 51 patients (19 males and 32 females) aged between 14.1 and 30 years (mean age: 21.2 years). Group 2 (G2) consisted of 52 patients (21 males and 31 females) aged between 14.2 and 29.11 years (mean age: 19.9 years). G1 started orthodontic treatment not receiving any post-procedure communication, while G2 received these messages via SMS or WhatsApp Messenger (WhatsApp Messenger Inc., Mountain View, California, USA). The communication through messages (only one time) was established right after the fixed orthodontic appliances were installed.

The fixed orthodontic appliances were installed in all patients from permanent maxillary right first molar to the left maxillary first molar. The initial orthodontic archwire was 0.012-in or 0.014-in nickel-titanium (NiTi). Archwires for leveling were attached with individual elastomeric rings. Before treatment, a single orthodontist applied the Modified Corah Dental Anxiety Scale (MDAS) to patients and they completed the VAS for pain perception, during the orthodontic appointment. MDAS assessed the level of anxiety reported by the patient during the treatment. Scores below 5 indicated very low level of anxiety; scores between 6 and 10 indicated low level; scores between 11 and 15 indicated moderate level; and scores between 16 and 20 indicated extreme anxiety.[18]

Pain was assessed by using 100-mm VAS at baseline and ten times in a follow-up period along predetermined time points: T_0) before the installation of appliances; T_1) immediately after the installation; T_2) 8 hours after the installation; T_3) 24 hours after the installation; and daily up to the 7th day (from T_4 to T_9). The last assessment was scored in the 14th day (T_{10}). All patients received the VAS form to fill at home at the first orthodontic appointment.

For the G2 individuals, text messages were sent once to the patients right after the first appointment, in order to improve their motivation, clarify the treatment approach and ask about their well-being in the early stage of orthodontic treatment.[17]

In the first clinical appointment after the 14th treatment day, the patients answered a questionnaire that registered their perception of pain and the eventual use of analgesics during the treatment. A new VAS was applied to assess the potential alterations in the daily routine of patients, related to the experienced pain. The text messages were sent by the same researcher, as well as the collection and assessment of all data.

STATISTICAL ANALYSIS

The comparison of pain perception among different groups and timings was performed using two-way ANOVA test with repeated values for timing. For multiple comparisons, Tukey test was applied. For the comparison of groups considering MDAS, Mann-Whitney test was used. Independent *t*-test was applied to compare groups and indicate if the treatment affected or not the daily routine of patients. Chi-square test associated the use of analgesics and the alterations in the routine of patients. The outcomes of MDAS and VAS were compared with Spearman's correlation coefficient. All the statistic tests were performed with Statistica (StatSoft Inc., Tulsa, USA) software package version 13, with significance level set at 5%.

RESULTS

The subjects included in the present study (n=103) were divided into two groups paired by age and sex. Chi-square and *t*-tests showed no statistically significant differences between groups, confirming sample pairing (p=0.74 and p=0.14, respectively).

According to MDAS, low-level anxiety was observed in 42.7% of the patients (G1=21; G2=23). Extreme anxiety was observed only in 7.8% (G1=5; G2=3) of the patients. The same tendency regarding anxiety results was found when the groups were analyzed separately (Table 1). Mann-Whitney test (p=0.259) indicated no statistically significant differences in the anxiety rates reported in both groups.

To assess the level of pain, the patients were requested to complete the VAS before and after the installation of fixed appliances (T_0 and T_1, respectively). Patients with pain before the installation were replaced in the sample. In G1, the mean pain level observed immediately after the appliance placement was 10.8mm, while in G2 it was 7.2mm (Table 2). Comparisons of pain levels between groups in each time point were performed (from T_0 to T_{10}). This procedure enabled to evaluate if the text messages sent to Group 2 were efficient in reducing the perception of pain.

The G2 reached lower pain level than G1 in all time points, except in the T_{10}. Table 2 and Figure 1 show that patients in G1 and G2 reported higher scores for pain in the 2nd treatment day (G1=36.9 ± 3.1 mm; G2=26.2 ± 3.2 mm), and lower scores in the 14th day (G1=1.2 ±1.2 mm; G2=2.9 ± 1.5 mm). Statistically significant differences between groups were observed within 8 hours after treatment, as well within the 2nd, 3rd and 4th treatment days.

In order to investigate if the level of anxiety (MDAS) influences the pain perception (VAS), a correlation was performed among the different time points between groups. In all time points, statistically significant higher scores for pain perception were observed in patients with higher levels of anxiety ($p<0.05$), except for T_3 in G2 ($p>0.05$) (Table 3).

When the patients returned for appointment, they were asked about the use of analgesics for pain control. Nearly 36.9% (n=38) of the patients used analgesics during the study. Chi-square test showed a statistically significant difference ($p=0.034$) between groups. Most of the patients under analgesic drugs were found in Group 1 (n=24; 47.1%) (Table 4).

Most patients (52.9%) stated that their routine was affected by the orthodontic treatment. Statistically significant outcomes were observed between groups. Patients in G1 were more affected by the orthodontic treatment in relation to G2 ($p=0.013$). When this alteration was quantified (VAS), G1 presented a mean value of 18.8 ± 2.2 mm and G2, of 9.9 ±1.5mm, a difference considered statistically significant ($p=0.002$), as seen in Table 5.

Table 1 - Distribution of the anxiety rates scored based on Corah's scale (MDAS) in Groups 1 and 2.

MDAS	G1		G2	
	n	%	n	%
Very low level of anxiety	12	23.5	16	30.8
Low level of anxiety	21	41.2	23	44.2
Moderate anxiety	13	25.5	10	19.2
Extreme anxiety	5	9.8	3	5.8
Total	51	100.0	52	100.0

G1: group 1; G2: group 2; According to Mann-Whitney test, statistically significant differences were not observed between groups (p = 0.259).

Table 2 - Mean (mm) and standard deviation observed for the perception of pain assessed with VAS, distributed in relation to period.

Period	G1		G2	
	mean	SD	mean	SD
Pre (T_0)	0.0	0.0	0.0	0.0
Immediately (T_1)	10.8	1.7	7.2	1.8
8h (T_2)	21.6*	2.5	14.3	1.8
24h (T_3)	32.1	2.7	24.3	3.0
2nd day (T_4)	36.9*	3.1	26.2	3.3
3rd day (T_5)	29.2*	3.1	19.0	2.6
4th day (T_6)	19.1*	2.3	12.6	1.9
5th day (T_7)	12.7	1.5	9.3	1.7
6th day (T_8)	7.4	1.1	5.8	1.2
7th day (T_9)	4.3	0.7	4.0	1.0
14th day (T_{10})	1.2	0.3	2.9	1.5

VAS: Visual Analogue Scale; ANOVA (F = 5.05; p = 0.027*); G1: group 1; G2: group 2; SD: standard deviation; *: statistically significant difference between groups ($p<0.05$); T_0) before the installation of appliances; T_1) immediately after the installation; T_2) 8 hours after the installation; T_3) 24 hours after the installation; T_4 to T_9) daily up to the 7th day after treatment; T_{10}): 14th day.

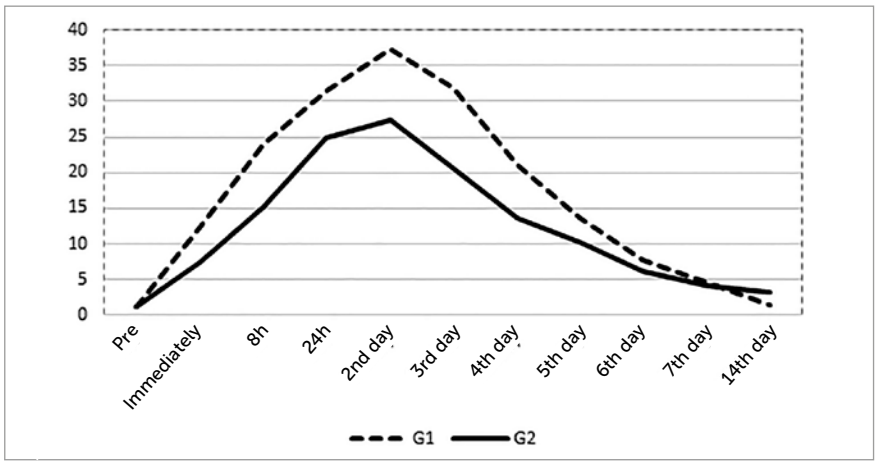

Figure 1 - Mean values of pain perception measured in VAS throughout the evaluated time points.

Table 3 - Correlation between the outcomes of anxiety (MDAS) and pain perception (VAS).

Correlation	G1		G2		G1 + G2	
	r	p	r	p	r	p
MDAS x VAS T_1	0.36	0.010*	0.35	0.010*	0.33	0.001*
MDAS x VAS T_2	0.28	0.043*	0.27	0.054	0.31	0.001*
MDAS x VAS T_3	0.35	0.011*	0.53	<0.001*	0.45	<0.001*
MDAS x VAS T_4	0.39	0.005*	0.59	<0.001*	0.48	<0.001*
MDAS x VAS T_5	0.35	0.013*	0.57	<0.001*	0.47	<0.001*
MDAS x VAS T_6	0.29	0.037*	0.50	<0.001*	0.41	<0.001*
MDAS x VAS T_7	0.29	0.043*	0.42	0.002*	0.38	<0.001*
MDAS x VAS T_8	0.41	0.003*	0.47	<0.001*	0.45	<0.001*
MDAS x VAS T_9	0.43	0.002*	0.36	0.008*	0.41	<0.001*
MDAS x VAS T_{10}	0.35	0.013*	0.28	0.044*	0.29	0.004*

MDAS: modified scale for anxiety in Dentistry; VAS: visual analog scale; G1: group 1; G2: group 2; r: correlation coefficient; p: significance value; T_1) immediately after the installation; T_2) 8 hours after the installation; T_3) 24 hours after the installation; T_4 to T_9) daily up to the 7th day after treatment; T_{10}): 14th day; *: statistically significant correlation (p<0.05).

Table 4 - Distribution of patients using analgesics in groups 1 and 2.

Group	Yes		No	
	n	%	n	%
G1	24	47.1	27	52.9
G2	14	26.9	38	73.1

Chi-square test (p=0.034).

Table 5 - Distribution of G1 and G2 regarding the routine alterations by treatment, mean and standard error (SE) of the outcomes of VAS (visual analog scale) regarding the patients in groups 1 and 2 that reported their routine affected (T_{11}).

G1		G2		p
n	%	n	%	
Routine alteration				
yes: 27	52.9	yes: 15	28.8	0.013*
no: 24	47.1	no: 37	72.1	
VAS (T_{11})				
mean	SE	mean	SE	0.002**
18.5	2.2	9.9	1.5	

* Chi-square. ** independent t test.

DISCUSSION

The use of orthodontic appliances may trigger discomfort, especially in the early treatment phase when physical and psychological adjustments occur. Specific aspects, such as the severity of the malocclusion and patient's age, may influence on the level of pain reported during treatment. In order to avoid age influence, only young patients (aged from 14 to 30 years) were included in this study. Regarding initial malocclusion, all patients presented discrete or moderate crowding. In these patients, the treatment started with 0.012-in or 0.014-in NiTi archwires (archwire set up was reported for methodological purposes, in particular, because the association of orthodontic archwire type and pain perception is not confirmed by the scientific literature).[19,20]

Considering the influence of sex on pain perception and also the fact that most of the patients were females (n=63), Groups 1 and 2 were compared regarding sex distribution and presented compatibility (p=0.74). This information is important to confirm the homogeneity of the groups and to reduce the risk of bias from variables that could influence the outcomes. This procedure is justified in other scientific studies that indicated more expressive pain perception in females compared to males.[7,21,22]

On the other hand, pain is not exclusively associated with physical stimuli, but also related to cognitive and emotional aspects. Anxiety is pointed to as the main psychological aspect related to the perception of pain.[8] According to MDAS, most of the patients (42.7%) classified themselves within a low level of anxiety. Yet the level of anxiety was similarly distributed between groups (p=0.259) (Table 1). This outcome suggested that both groups had similar anxiety rates before treatment. This aspect is extremely important when comparing both groups regarding pain intensity and patients' behavior after receiving text messages.

According to the present study, patients with higher anxiety level are more prone to complain of intense pain (Table 3). The same outcome was observed for the analysis within groups. Beck et al[20] found similar results with the application of MDAS and the State-Trait Anxiety Inventory (STAI). The authors observed statistically significant findings, showing that higher anxiety rates lead to higher pain perception levels. Similarly, Bergius et al[21] observed that despite the lack of statistically significant differences between the anxiety levels, patients more anxious reported higher pain scores in the VAS.

Considering anxiety as a contributing factor to pain experience,[23] patient-management strategies, such as text messaging, play an important part controlling anxiety and reducing the perception of pain. Compared to G1, G2 presented lower values for the perception of pain along all time points (Table 2 and Fig 1). However, the patients in both groups referred more pain in the 2nd treatment day (Group 1 = 36.9 ± 3.1 mm; Group 2 = 26.2±3.2mm), while less pain was referred in the 14th treatment day (Group 1 = 1.2± 1.2mm; Group 2 = 2.9±1.5mm). Statistically significant differences were observed between groups within 8 hours after the installation of the orthodontic appliances, as well within 2, 3 and 4 days. Accordingly, Bartlett et al[13] showed that a single phone call after the installation of fixed appliances reduced the level of anxiety and consequently the related perception of pain. Similar findings were observed by Keith et al[17] and Cozzani et al.[8] These authors sent text messages to the patients for 7 days[17] and assessed the efficiency of text messaging and phone calls for controlling pain[8], respectively. These studies highlight the importance of communication in Orthodontics (via phone calls, text messaging, and e-mails), which includes providing information about treatment progress, instructions about potential discomfort, and encouraging messages.[8,13,17]

According to Table 4, in G1 nearly half (47.1%) of the patients considered analgesics necessary for pain control, while in G2 less patients had the same opinion (26.9%). This outcome confirms that text-messaging could reduce the perception of pain and the consequent need for analgesics. The use of analgesics is common in the early phase of orthodontic treatment.[24] Hence, any approach, such as text-messaging, to decrease the use of medication may benefit patients. These findings corroborate the studies of Cozzani et al[8] and Johal et al,[25] which observed that most of the patients under analgesic medication did not receive text messages. In their studies, statistically significant difference between groups was observed in the first day of investigation. Bergius et al[21] reported, more specifically, that the use of analgesics

is more common in the first day after the installation of fixed appliances in women.

Possibly, the present study is the only one to investigate the potential impact of pain in the routine of orthodontic patients. Forty-two (40.77%) patients complained about routine alterations due to the pain experienced during the initial phase of treatment. The comparison between groups revealed statistically significant differences. In particular, patients in G1 had their routine more affected (52.9%) by the pain than the patients in G2 (28.8%), as seen in Table 5. When patients that reported routine alterations quantified how much impact in their lives was caused by the pain experience (VAS), statistically significant differences (p=0.002) were also observed between groups. G1 presented a mean value of 18.8±2.2mm and G2, of 9.9±1.5mm (Table 5). In this context, patients that did not receive text messages presented more discomfort and alteration in the daily routine. Clarifying the potential positive and negative experiences during the orthodontic treatment, as well as asking about the patient well-being through text messaging, may influence the treatment success. In practice, it is important because optimal treatment outcomes depend on strategies to minimize discomfort and pain experienced by the patients.[17] Comfort and quality of life during the daily routine may motivate the patient towards a more collaborative attitude during the orthodontic treatment.[26]

The present study provided relevant data regarding pain perception and the level of anxiety in orthodontic patients after the installation of fixed appliances. As a limitation of the study, the patients were evaluated only 14 days after the installation of orthodontic appliances. In future research, we may consider sending text messages or phone calls follow-up for a longer period of evaluation. Based on the findings, the present study suggests the use of text messages to explain and clarify the treatment progress in order to minimize the perception of pain in the early phase of orthodontic treatment.

CONCLUSION

» Anxious patients presented higher pain levels during initial phase of orthodontic treatment.

» When the perception of pain was compared between groups, significantly reduced pain was perceived by patients within 8 hours after appliance installation, as well within the 2nd, 3rd and 4th treatment days when they received the post-procedure message.

» A significant difference in routine alteration was observed between groups, patients that were not contacted with text message had their routine affected twice as much due to the pain experienced.

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Improving shear bond strength of metallic brackets after whitening

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Objective: To evaluate a protocol for bonding metallic brackets after bleaching with hydrogen peroxide (HP).

Methods: 60 extracted maxillary premolar were randomly divided into an unbleached control group and two groups bleached with a solution of 35% hydrogen peroxide prior to bonding. The teeth in one of the treated groups were bonded immediately after bleaching; while the other group was treated with 10% sodium ascorbate immediately after bleaching and before bonding. The teeth in all groups were stored in an artificial saliva solution for 7 days after bonding. The shear bond strength data was measured in megapascals (MPa) and the fail attempts were verified. The significance level was established at $p < 0.05$.

Results: The unbleached group, in which brackets were bonded to untreated enamel, had the highest bond strength values (11.0 ± 5.7MPa) in comparison to the bleached group (7.14 ± 40MPa), in which brackets were bonded to recently bleached enamel. Slightly improved bond strength was observed in the antioxidant group (8.13 ± 5.4MPa), in which the teeth were bleached and then the antioxidant was applied to the teeth before bonding. Unbleached and bleached groups showed statistically significant difference for shear bond strength ($p=0.03$) and load strength ($p=0.03$); no significant differences were noted between unbleached and antioxidant groups ($p=0.52$).

Conclusion: The antioxidant treatment applied immediately after bleaching was effective in reversing the reduction in shear bond strength of brackets after tooth bleaching.

Keywords: Orthodontics. Tooth bleaching. Shear bond strength. Hydrogen peroxide. Sodium ascorbate.

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INTRODUCTION

The increasing popularity of tooth whitening/bleaching is having a considerably impact in smile design and dentistry.[1] Many whitening systems are used to bleach enamel, some of them have concentrated solutions of hydrogen peroxide (HP), which is the most commonly used agent for whitening discolored teeth. These solutions are subjected to either heat or light to accelerate the bleaching reaction.[2]

Hydrogen peroxide can penetrate tooth structure for adequate stain removal. This penetration is effective due to the low molecular weight of hydrogen peroxide and its ability to denature proteins. This capability increases the tissue permeability allowing ions to move through the teeth.[3] Hydrogen peroxide releases free oxygen radicals that lead to some cellular changes.[4]

Continuous whitening for at least two to four weeks has been shown to achieve a significant difference in bond strength. Nevertheless, some patients that have had their teeth previously bleached, often become more aware of orthodontic problems and want to be treated.[5]

To defeat clinical matters associated to compromised bond strength of teeth following bleaching, several techniques have been suggested. For example, Barghi and Godwin[6] pre-treated bleached enamel with alcohol, while Kalili et al.[7] and Sung et al.[8] recommended to use adhesives containing organic solvents. It is often recommended, however, to postpone any bonding procedure until the whitening sessions are finished, due to the transitory decrease of bond strength found in freshly bleached enamel.[9-11] It is recommended a waiting period of 24 hours up to four weeks for bonding procedures after bleaching.[11-16] Decreased bond strength in bleached enamel has been associated to the inhibition of polymerization of resin-based materials as regards to the presence of residual oxygen.

Considering all the reported interactions that impact the bond strength of composite on bleached enamel,[17] the present research arises as to whether there is any protocol that can be used to defeat the detrimental effects of bleaching on enamel. Thus, the purpose of this *in vitro* study was to evaluate a bonding protocol of metallic brackets after whitening with hydrogen peroxide. The null hypothesis is that there would be no significant differences in shear bond strength between the unbleached group and the antioxidant group.

MATERIAL AND METHODS

Preparation of specimens

This experimental *in vitro* study was approved by the institutional ethical committee of *Universidad del Valle* (#018-07). Total sample of 60 human maxillary premolars extracted for orthodontic purposes were collected and stored in saline solution that was changed every three days. The criteria for tooth selection included intact buccal enamel with no cracks caused by the extraction forceps, no caries, and no pretreatment with any chemicals.

The samples were randomly divided into three equal groups of teeth, as follows (confidence interval set at 95%): A control group and two groups bleached with a 35% solution of hydrogen peroxide. Unbleached group (n=20) served as a control group; bleached group consisted of specimens bonded immediately after treated with hydrogen peroxide (n=20), while Antioxidant group specimens (n=20) were treated with a 10% solution of sodium ascorbate agent just before bonding and immediately after bleaching with the same agent used in bleached group. Sodium ascorbate is a form of vitamin C that can be used as an antioxidant and as an acidity regulator.

Bleaching procedures

A commercial 35% solution of hydrogen peroxide in the form of an in-office bleaching gel (Pola Office®, SDI Limited, Victoria, Australia) was applied to the enamel surfaces of the embedded teeth from the bleached and antioxidant groups for two cycles of 20 minutes each, according to the manufacturer's instructions.

Application of antioxidant

After whitening procedure, the teeth from the antioxidant group were treated as follows: 10 ml of 10% sodium ascorbate was dripped on the enamel surfaces of the teeth and agitated with a sterile brush. After 15 minutes, the enamel was washed with distilled water and dried.

Bonding of brackets

Next step was to bond brackets to the buccal surfaces of all premolar in each group. Sixty identical stainless

steel Orthos brackets (Ormco® Corporation, Orange, CA) with an 0.022 x 0.028-in slot were used in this study. Right and left first maxillary premolars brackets with a bracket pad surface area of 12.95 mm^2 were used.

The brackets were bonded to specimens at 24°C room temperature. Before composite bonding, all specimens were conditioned with a 37% phosphoric acid gel (3M Unitek, Monrovia, CA) for 30 seconds, then rinsed with water for 10 seconds and dried. The bonding primer used for all groups was Orthosolo® (Ormco Corporation, Orange, CA), which has alcohol in its composition.

For all the groups, the brackets were bonded with Enlight® bonding system (Ormco Corporation), according to the manufacturer's instructions. This composite was used, instead of others, because is the one that is routinely used in authors' clinic. After the bracket was properly positioned on the tooth, each bracket was subject to 300g of force[18] measured with a pressure dynamometer, and excess bonding resin was removed with a sharp scaler. The composite was light-cured for 10 seconds with a LED system (Ultralume 5, Ultradent, South Jordan, Utah) at a distance of 1 cm from the bracket.

The teeth then were embedded in acrylic placed in phenolic rings (Veracryl®, New Stetic, Medellín, Colombia). A wood mounting jig was used to position the rings so that the facial surfaces of the teeth were positioned perpendicular to the bottom of the mold. The labial surfaces were oriented parallel to the applied force during the shear test.

Artificial saliva immersion

Immediately after the bonding process, the specimens from all three groups were immersed in 250 ml of artificial saliva solution (Salivar®, Farpag Laboratories, Bogota, Colombia) at 37°C for 7 days. The artificial saliva solution had an electrolyte composition similar to the human saliva. After the specimens were removed from the artificial saliva, the enamel surfaces were rinsed with an air/water syringe for 30 seconds before the shear bond test.

Analysis of shear bond strength

The shear bond strength of the samples was measured with an Instron™ tensile testing machine (Instron Co., Norwood, MA) that was programmed to measure a crosshead speed of 1 mm/min. An occluso-gingival oriented load was applied to the bracket, and produced a shear force at the bracket-tooth interface. A computer connected with the test machine recorded the results of each test in megapascals (MPa).

Statistical analysis

Comparisons of means were made with Student's *t*-test and a Kaplan-Meier estimator to verify the failure time of the shear bond strength between the groups. The failures between the groups were analyzed with a Cox test. Both experimental groups were compared to each other and with the Control Group.

All statistical analyses were performed with Excel® and with Stat® software package (version 8.0, Stata Corporation, College Station, Texas). Significance for all statistical test was predetermined at $p < 0.05$.

RESULTS

Descriptive statistics were computed for all analyzed variables and described as mean and standard deviation (SD) or as median and interquartile range (Table 1).

The results for the Student *t*-test indicated no significant differences between Unbleached group and Antioxidant group, and between Bleached and Antioxidant groups, while comparisons between Unbleached and Bleached groups showed statistically significant difference for shear bond strength values and load strength values. Means for shear bond strength were: Unbleached group = 11.0±5.7; Bleached group = 7.14±4; Antioxidant group = 8.13±5.4 (Figs. 1, 2, 3).

The results of the Kaplan-Meier estimator indicated no significant differences between the groups; even though the control group showed a different behavior when a 0.75 MPa load was applied (Fig. 4).

Table 1 - Descriptive statistics for the shear bond strength of the three groups.

Variable	Group A (Control)	Group B (Bleached)	Group C (Antioxidant)	P*	P**	P***
Displacement						
Mean±SD	0,54±0,25	0,62±0,32	0,51±0,39	0,8	0,35	0,37
(Iqr)	(0,39-0,59)	(0,34-0,87)	(0,27-0,84)			
Load						
Mean±SD	0,14±0,076	0,09±0,05	0,11±0,07	0,03	0,1	0,52
(Iqr)	(0,06-0,18)	(0,05-0,13)	(0,05-0,15)			
Tensile						
Mean±SD	11±5,7	7,14±4	8,13±5,4	0,03	0,1	0,52
(Iqr)	(4,8-13,8)	(4,16-10,28)	(3,7-11,3)			

Comparisons between: *Group A x B, **Group A x C, ***Group B x C (in MPa). p = 0.05; SD = standard deviation; Iqr = interquartile range.

Figure 1 - Displacement for each group.

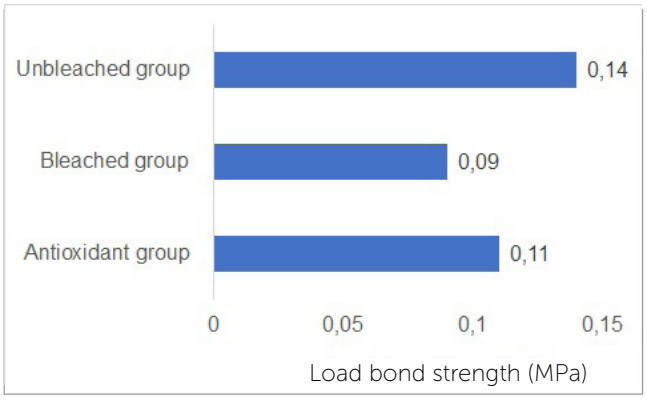

Figure 2 - Load bond strength (MPa) for each group.

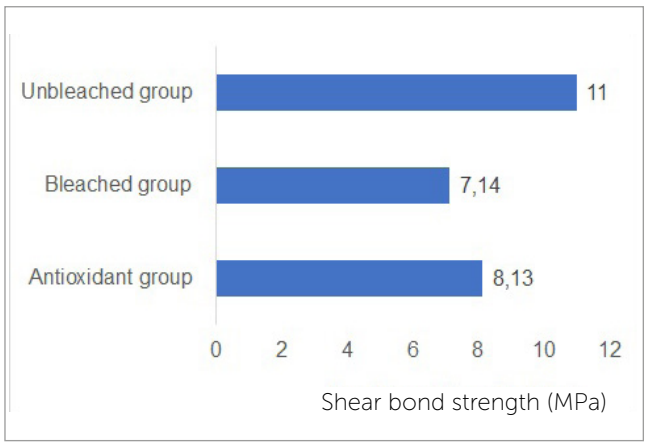

Figure 3 - Shear bond strength (MPa) for each group.

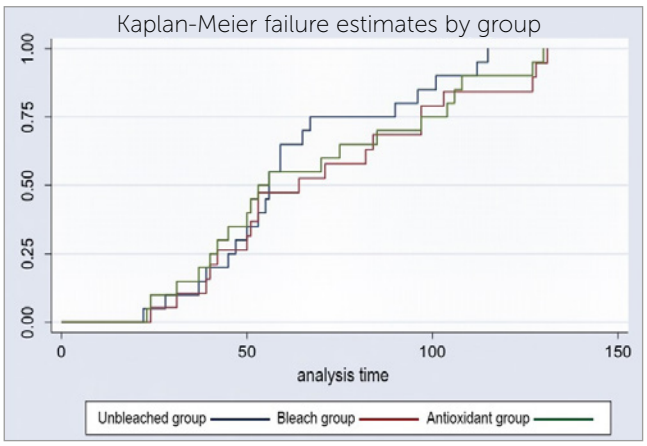

Figure 4 - Kaplan-Meier failure estimates by group. P= 0.2.

DISCUSSION

The null hypothesis was accepted, since there were no significant differences between the unbleached group and the antioxidant group. This *in vitro* study determined a bonding protocol of metallic brackets after bleaching with hydrogen peroxide (HP). All groups were bonded with an alcohol-base bonding agent (Orthosolo[19]); Group C also was treated with sodium ascorbate after the bleaching process, in an attempt to restore the reduced shear bond strength of metal brackets, as suggested by Bulut et al[20].

The present results indicate that sodium ascorbate applied to bleached enamel before immediate bonding with composite resin appeared to renew the decreased shear bond strength of metal brackets. This study also showed a reduction in shear bond strength of brackets post-bleaching (Bleached group), contrary to the control group (Unbleached group). Studies have shown that bond strength values required to withstand normal orthodontic forces are between 8 and 9 MPa.[21]

Some researchers have attempted to clarify the reduction in bond strength in enamel bleached with carbamide peroxide. Literature indicate that weak bonding surfaces and staining susceptibility are related to enamel surface morphology, with varying degrees of surface roughness and structural changes occurring through loss of prismatic formation.[22-24]

Previous investigations[9,11,12,15,23] have indicated that *in vitro* immersion of specimens in artificial saliva, distilled water or even saline for at least 7 days showed a complete reversal of the reduced enamel bond strength. This process assumes that the immersion procedure removes residual oxygen from the bleaching material. Human saliva is supposed to have comparable action on the enamel after whitening.

Uysal et al.[16] demonstrated the effect of 35% hydrogen peroxide bleaching agent on shear bond strength of metallic orthodontic brackets bonded to premolars immediately after whitening. This study concluded that immersing bleached teeth in artificial saliva does not have a significant effect on shear bond strength, but postponing bonding procedures for 2 to 3 weeks might be favorable. Uysal et al.[16] agree with Bishara et al.,[25] who have reported that immediate bond strength values were not affected adversely by 10% carbamide peroxide bleaching for a week. However, Miles et al.[11] reported a significant decrease in bond strength of ceramic brackets after 72 hours of whitening with the same agent.

Josey et al.[23] suggested that acid-etched bleached teeth have lost their regular prismatic boundaries, and such variations might affect the retentive qualities of dental restorations or adhesives applied to enamel surface. These investigators also reported that under experimental conditions, hydrogen peroxide diffuses out of the teeth from 1 to 6 weeks.

To eliminate clinical effects associated to compromised bond strength post-whitening, Sung et al.[8] suggested the use of adhesives containing organic solvents. They noted an interaction between bond strength to bleached enamel and the bonding agent used. Groups using Optibond™, an ethanol-based bonding agent, showed no significant reduction in bond strength between bleached and unbleached groups. However, All-Bond 2® and One-Step® bonding agents (Bisco Dental Products, Richmond BC, Canada) are acetone-based; these agents showed a significant decrease in bond strength between bleached specimens compared to unbleached controls.

These observations agree with Kalili et al.[7] regarding the differences in bond strength between various bonding agents, which may be associated to the presence of alcohol in the primer. They also mentioned that the application of an alcohol-based bonding agent can minimize the inhibitory effects of the whitening process by the interaction of alcohol with residual oxygen.

Bulut et al.[5] demonstrated that bleaching of enamel with 10% CP immediately before bonding leads to a decrease of bracket tensile bond strength. They also showed that in samples to which antioxidant was dripped for 10 minutes immediately after whitening, tensile bond strength was found to be at the same level as in those samples kept just in artificial saliva solution after 7 days.

Lai et al.[26] also immersed the bleached specimens in 10 per cent sodium ascorbate solution for three hours. Their results showed that sodium ascorbate allows free-radical polymerization of the adhesive resin to proceed without premature termination by restoring the altered redox (reduction-oxidation) potential of the oxidized bonding substrate, thus reversing the compromised bonding. Khoroushi et al.[27] and Kimyai et al.[28] also suggest that shear bond strength can be restored after the application of an antioxidant in previous bleached teeth.

In the present study, three previously reported factors were used to eliminate the effect of whitening on shear bond strength of metal brackets: an ethanol-based bonding agent (Orthosolo®), the application of a sodium ascorbate solution for 15 minutes, and artificial saliva immersion for 7 days. According to the present results, those three factors can be used as a protocol to restore the effect of whitening in shear bond strength of metal brackets. Since this is an *in vitro* study, clinical bond-failure investigations are needed to validate the protocol performance proposed in this study.

CONCLUSIONS

1. The use of a 35% hydrogen peroxide in-office whitening system immediately before bonding reduces shear bond strength values.
2. Treating the bleached enamel surface with 10% sodium ascorbate reversed the decreased shear bond strength.
3. The use of an ethanol-based bonding agent with artificial saliva immersion during 7 days with the antioxidant may be an innovative option for fixed orthodontic treatment after whitening.

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A singular oral appliance to treat obstructive sleep apnea in CPAP non-adherent patients

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Introduction: The most prescribed treatment option for Obstructive Sleep Apnea (OSA) is CPAP; however, its adherence is limited. Oral Appliance therapy (OAT) is frequently an option or even an adjuvant, being the mandibular advancement Oral Appliance (OA_m) the most used prescription. It modifies the upper airway, improving the airway patency. OA_m construction is based on the occlusal plane to disocclusion. In this study, the DIORS® appliance was used, a singular OA_m, based on Neuro-Occlusal Rehabilitation concepts, that uses Camper's plane as a disocclusion reference, in order to achieve neuromuscular balance and functional stability.

Objective: This study primarily aimed to assess the DIORS® effectiveness in relation to clinical and polysomnographic outcomes. It was also evaluated if the use of DIORS® is as effective as titrated CPAP to treat CPAP non-adherent patients.

Methods: Twenty patients were included in this study. Objective and subjective clinical data were assessed at a sleep laboratory using all-night polysomnography, and Epworth Sleepiness Scale (ESS), taken at three moments: Baseline, CPAP titration, and using DIORS®. Analysis of respiratory parameters as apnea/hypopnea index (AHI), oxyhemoglobin saturation levels, the arousal index and daytime sleepiness were taken as criteria for a successful OAT.

Results: Respiratory and arousal parameters improved in both therapies, while DIORS® promoted a better ESS.

Conclusion: Results from the present work support that DIORS® is a viable and effective adjuvant therapy for patients with moderate to severe OSA non-adherent to CPAP.

Keywords: Alternative treatment. Oral appliance therapy. Camper plane. Neuro-occlusal rehabilitation.

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»The author Denise Fernandes Barbosa participates in the invention / development of DIORS® (*Dispositivo Intra Oral Restaurador do Sono®*, Intra Oral Sleep Restoration Device), used in the present research.

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INTRODUCTION

The most prescribed treatment option for Obstructive Sleep Apnea (OSA) is Continuous Positive Airway Pressure (CPAP), as this is considered the "gold standard" treatment[1]. However, adherence to CPAP is limited[2,3] and therefore for non-adherent patients, Oral Appliance Therapy (OAT) is often an option or even an adjuvant treatment.[1,4-9] The most common type of oral appliance is the mandibular advancement Oral Appliance (OA_m). Several studies compare CPAP to OA_m, and show that CPAP is more effective in reducing Apnea/Hypopnea Index (AHI).[3,5] On the other hand, other studies found a lack of long-term relevant differences between CPAP and OA_m for mild to moderate OSA, when both treatment modalities are objectively titrated[3]. In addition, excessive sleepiness levels give rise to a primary and clinically important outcome in a sleep apnea patient's follow-up, apparently showing no difference between OA_m and CPAP treatments.[10,11] Recent studies have indicated that, despite the advantage of CPAP on AHI reduction, a high compliance to OA_m, compared to CPAP[11], leads to similar therapeutic effectiveness.

OA_m design from the new generation of oral appliances may impact on the therapeutic efficacy and effectiveness,[8,11-12] with advanced main features, construction techniques, and the ability for individualization. Most OA_m use the Occlusal Plane (OP) orientation in the construction of dental disocclusion to mandible advancement. Historically, patient's occlusal line has been assessed comparing the inclination to selected craniofacial reference lines. Some authors consider the Camper's Plane (CP) the most suitable plane to orient the OP (Fig 1), based on fixed individual skull structures. Although neither enough long-term studies or authentic data are available advising on a single reliable landmark for the perfect OP, most have suggested CP for artificial orientation of OP.[13,14]

The OP can show differences in the orthogonal planes (sagittal, coronal and transversal), such as a unilateral masticatory function, generating skeletal asymmetries between the reference points of the orthogonal planes. Therefore, in the concepts of Neuro-Occlusal Rehabilitation (NOR),[15] the main reference for a diagnosis is clinical examination of OP associated with CP to decide which treatment[16] would bring neuromuscular balance and functional stability. Such diagnosis main tool is Gnathostatic Model (GM), observing the sagittal, coronal and transversal plane, to verify whether or not there is a CP and OP[15] parallelism (Fig 2).

Anatomically, the tongue maintains several relationships with airway space;[17,18] and so, with the hyoid bone and pharyngeal muscles.[19] By changing mandible posture and tongue protrusion of an OSA patient, supra-hyoid muscles activity would also change, since it would clearly underline the role of tongue activity in maintaining upper airway patency in upper airway space.[20]

Respecting anatomic and physiologic conditions, and muscle origin and insertion to obtain functional balance, the DIORS® (*Dispositivo Intra Oral Restaurador do Sono®*, Intra Oral Sleep Restoration Device) (Fig 2) was created.

Thus, the present study aimed at evaluating if the use of DIORS®, a model of OA_m using the CP for orientation to disocclusion, is sufficient to treat OSA patients not adhering to CPAP therapy.

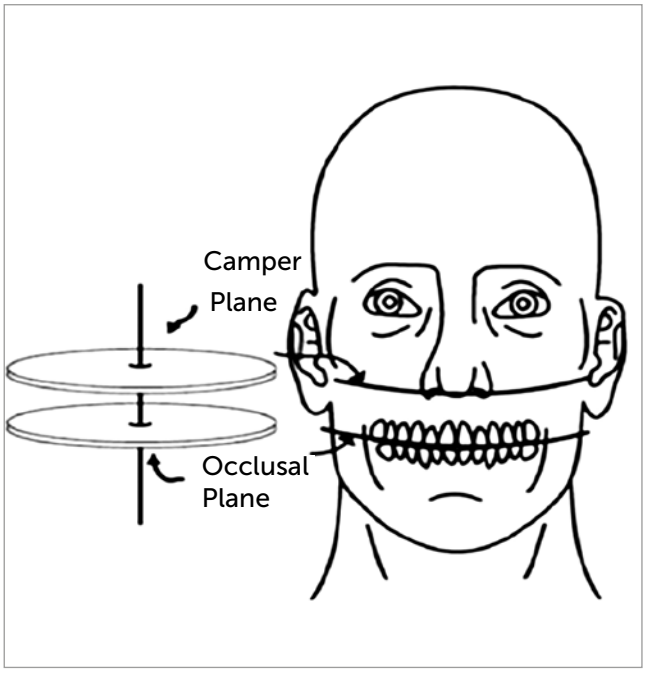

Figure 1 - Frontal view of Camper's plane (ala-tragus) and occlusal plane.

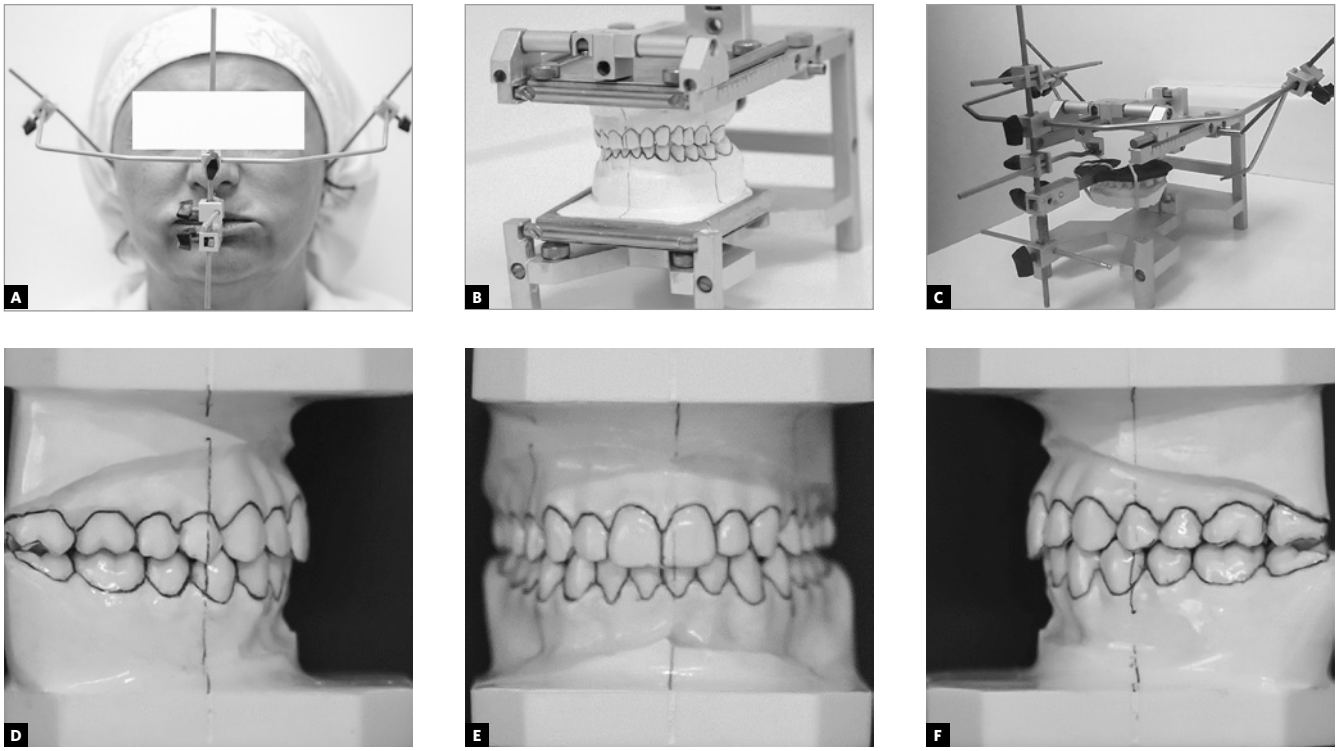

Figure 2 - *Modus operandi* to make the gnathostatic model: **A**) gnathostatic facial arch; **B**) gnathostatic model construction; **C**) facial arch transferred to the Planas gnathostat to make the gnathostatic model; **D**) gnathostatic model, right side; **E**) gnathostatic model, frontal view; **F**) gnathostatic model, left side.

METHODS

Study strategy

To compare the use of DIORS® and CPAP therapy, CPAP non-adherent subjects were selected and the effects of DIORS® were assessed. For this purpose, pre and post OAT subjective data, Epworth Sleepiness Scale (ESS), and polysomnography (PSG) objective data were compared. Three phases of the same patient were assessed: baseline, with CPAP titration (without adherence), and after DIORS® adjustment (with adherence). The criteria for success in therapies were assessed with Arousal Index and respiratory parameters (Apnea/Hypopnea Index [AHI], Oxyhemoglobin Saturation [O_2Sa], and daytime sleepiness). At the DIORS® phase, the protocol was of 2-3 month for a change.

Subjects

The Medical Ethics Committee of the *Faculdade de Medicina de Jundiaí* (SP, Brasil) (CAAE: 55049616.4.0000.5412 P.N. /1.529.053) approved this study that included patients attending the private clinic of one of the authors.

Anthropometric data of 20 subjects, 11 men and 9 women (Table 1), were consecutively collected. All patients non-adherent to CPAP treatment were indicated to adapt to OAT.

Subjects selected should be adult, man or women, complaining of snoring, sleepiness, choking, with at least 8 teeth per dental arch, with positive diagnosis for OSA by PSG. Data was collected from 7 mild (5-15 ev./h), 8 moderate (16-30 ev./h) and 5 severe (>30 ev./h) OSA subjects. This study excluded patients without all PSG (baseline, CPAP titration and DIORS® advancement), having mandibular advancement of less than 5 mm, a mandibular opening of less than 35 mm, tooth decay, extensive periodontal disease, predominant central sleep apnea, or muscle/joint pain.

Questionnaires

At a sleep laboratory, the Epworth Sleepiness Scale (ESS) was used to evaluate subjective daytime sleepiness, taken at three moments: baseline, CPAP and DIORS® titration. During the follow-up, partner and patient were interviewed to measure snoring and adherence.

Table 1 - Mean / SD of baseline anthropometric data of all 20 patients (9 F and 11 M).

Variables	Mean (SD)
Age (years)	51,91 (12.66)
BMI (kg/height^2)	28.58 (4.76)
Neck circumference (cm)	39.10 (4.39)
Waist circumference (cm)	102.05 (14.15)

SD = Standard Deviation; BMI = Body Mass Index; F = Male; M = Male.

That moment was also used to assess how safe and resistant is the DIORS® material. The interview included the following questions: "*Are you using the DIORS®*"; "*Do you use the DIORS® all night?*"; "*Do you use the DIORS® every night of the week?*"; "*Is your partner snoring with the DIORS®?*"; "*Are you fully satisfied with the DIORS®*?"; "*Has the DIORS® ever broken?*".

Polysomnography

At the sleep laboratory, each subject was assessed regarding all-night baseline PSG. PSGs with CPAP titration and DIORS® were also assessed (2 to 3 months after OA_m therapy). For that, sleep specialist physicians used 28-channels Brain Wave II (PSG Neuro Virtual, Barueri/SP, Brazil) following the 2007 AASM Manual for Scoring Sleep[21]. The channels consisted of: Referential AC inputs (8 electroencephalographic [EEG], 2 electrooculogram [EOG], 3 auxiliary); Bipolar AC input (1 electromyogram [EMG], 1 electrocardiogram [ECG], 1 snore, 1 flow, 1 pressure, 1 oximetry, 2 efforts, 1 position, 1 LM and 2 Aux); and 3 DC input. Sleep stages (wake [W]: sleep stage 1 [N1], sleep stage 2 [N2], sleep stage 3 [N3], and sleep stage REM [R]). AHI was defined as the number of episodes of apnea plus episodes of hypopnea per hour of sleep. OSA was defined as AHI ≥ 5.

Treatment outcome

No consensus has been reached on how criteria for success should be defined[22]. Then, three success criteria were established regarding elimination or decreasing of AHI symptoms: 1) Successful (AHI < 5/h); 2) Partly successful (at least 50% reduction in AHI, but AHI > 5/h; and 3) Failure (persisting clinical symptoms, and/or less than 50% reduction in baseline AHI). Symptoms, adhesion, and satisfaction with the use of DIORS® were assessed by means of a questionnaire applied to patients and partners.

Protocol of oral appliance therapy

First, to build the GM, a detailed anamnesis was performed at the first appointment. Impressions of the dental arches and the face bow were took to construct the GM. To determine the constructive bite, a George Gauge bite fork™ (Space Maintainers Laboratories, Chatsworth, CA, USA) was used. A specialized dental technician built the custom-made OA_m with 65-75% maximum protrusion and a vertical opening of 3-4mm between incisor edges. The construction of the DIORS® required two gypsum casts: one for the GM, and one for the working model.

Then, at the second appointment, the DIORS® was placed. From that point, incremental advances of 1 mm were weekly performed, and the reports of patients regarding their experience with the DIORS® were also recorded. Such reports indicated a decrease in snoring, gasps, sleepiness, and/or based on physiological limitations. The efficacy of the DIORS® was determined by using additional PSG with DIORS® *in situ*, after at least 3 months.

DIORS® construction, disocclusion, and advancement mechanism[20]

The construction of this OA_m is based on the definition of an OA_m published by the AADSM[23]. Briefly, the DIORS® presented in this study is significantly different because it creates disocclusion and a position that allows a mechanism of advancement positioned on the posterior 2/3 of the tongue, on the lingual surface of the teeth.

Disocclusion is guided by the CP through a device that replicates CP in the working model. Therefore, the DIORS® performance promotes the protrusion of both the mandible and tongue (Fig 3).

Additionally, this OA_m is duly patented with the National Institute of Intellectual Property (INPI, patent MU 202012025341-6), registered under numbers 904831639 (DIORS®) and 906.231.833

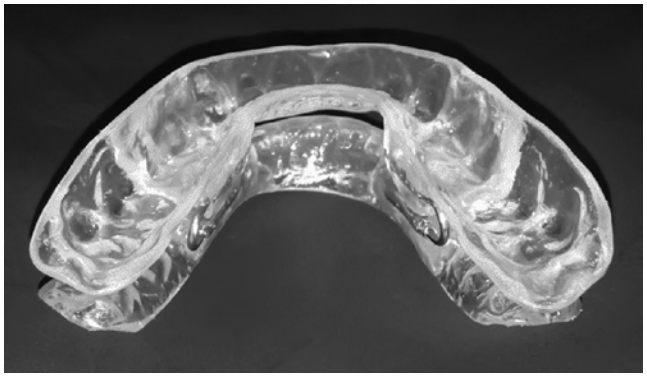

Figure 3 - DIORS® Brazilian OA_m (Intra Oral Sleep Restoring Device).

(DIORS®, *Dispositivo Intra Oral Restaurador do Sono*®, or Intra Oral Sleep Restoring Device).

Statistical analysis

First, descriptive statistics was used to characterize the sample. Then, an ANOVA generalized linear mixed model was set to compare the three experimental conditions as repeated measures. Based on the Shapiro-Wilk test and asymmetry and kurtosis coefficients, the residual adherence to Gaussian distribution was assessed. The Tukey-Kramer test was applied as *post-hoc* test.

Based on the results, state-of-the-art parametric techniques were used to describe a modern procedure to approach the issue. To assess the criteria for success and adherence patterns, chi-square was used, with a significance level of 5% in all tests.

RESULTS

Table 2 shows the variables studied. Regarding the success criteria for therapies with AHI, CPAP and DIORS® initial mean values were different ($p = 0.0001$) for the respiratory parameters (such as AHI, O_2Sa_{nadir} and AI). Regarding daytime sleepiness, no difference was noticed between CPAP and DIORS® at any sleep phase, except for TST-N2 mean ($p = 0.001$), which remained different at all phases, closer to normal in the DIORS®. Compared to the CPAP patients, DIORS® patients reported reduced symptoms ($p = 0.01$) of subjective sleepiness.

Besides, Table 3 shows adherence in DIORS® monitoring ($p < 0,05$). From the sample of individuals, three stopped using the DIORS® due to bariatric surgery (n = 2) and dental treatment (n = 1).

Table 2 - Mean (SD). ANOVA (p-value) and Tukey's test for variable mean in phases (baseline, after CPAP and titration), Average with equal superscript letters indicate no difference between them. Significance level was established as 5%.

Variables	Baseline	CPAP	DIORS®	p value
AHI/h	27.15 (27.90)^{A}	3.55 (3.20) ^{B}	6.16 (6.70) ^{B}	0.0001
Sleep Latency N1 (min)	34.87 (27.94) ^{A}	38.00 (21.82) ^{A}	34.99 (24.08) ^{A}	NS
TST (%) - N1	3.32 (3.21) ^{A}	3.65 (3.30) ^{B}	2.80 (0.71) ^{AB}	NS
TST (%) - N2	59.05 (9.13) ^{A}	51.56 (7.71) ^{AB}	55.10 (5.54) ^{B}	0.0015
TST (%) - N3	17.91 (6.96) ^{A}	23.88 (7.86) ^{A}	21.03 (5.67) ^{A}	NS
REM (%)	19.71 (5.02) ^{A}	20.91 (5.31) ^{A}	21.10 (2.77) ^{A}	NS
SE (%)	76.54 (12.84) ^{A}	71.62 (12.20) ^{A}	76.82 (10.42) ^{A}	NS
O_2Sa_{mean}/h (%)	92.97 (1.78) ^{B}	94.65 (1.60) ^{A}	93.57 (1.77) ^{B}	0.0005
O_2Sa_{nadir}/h (%)	82.68 (5.06) ^{B}	88.45 (4.51) ^{A}	87.45 (3.69) ^{A}	0.0001
AI/h	23.93 (23.08) ^{A}	6.56 (4.81) ^{B}	6.55 (4.89) ^{B}	0.0001
ESS	9.00 (5.77) ^{AB}	9.06 (5.38) ^{A}	7.22 (4.05) ^{B}	0.0122
BMI (Kg/m^2)	28.58 (4.76) ^{AB}	28.69 (4.64) ^{B}	29.34 (4.30) ^{A}	0.044
CPAP titration (cm/H_2O)	-	7.30 (1.92)	-	-
OA_m advancement (mm)	-	-	9.84 (2.67)	-

P<0.05. AHI= Apnea/Hypopnea Index; TST= Total Sleep Time; N1= sleep stage 1; N2=sleep stage 2; N3= sleep stage 3; REM= Rapid Eye Movement; SE = Sleep Efficiency; O_2Sa= Oxyhemoglobin Saturation; AI= Arousal Index; ESS= Epworth Sleep Scale; OA_m= Oral Appliance with mandibular advancement; CPAP= Continuous Positive Airway Pressure; NS- Non-Significant. A, B and AB= Superscript letters representing the Tukey test with a significantly different form.

Table 3 - Affirmative descriptive data about follow-up of DIORS® OA_m usage in 20 patients and partners interview (Chi-square test).

Questions	Yes - percentage (n)	p-value
Are you using the DIORS®?	85% (17)	0.002
Do you use the DIORS® all night?	85% (17)	0.002
Do you use the DIORS® every night of the week?	88.23% (15)	0.002
Is your partner snoring with the DIORS®?	58.8% (10)	0.467
Are you totally satisfied with the DIORS®?	88.23% (15)	0.002
Has the DIORS® ever broken?	5% (1)	0.001

OA_m= Oral Appliance with mandibular advancement.

DISCUSSION

Although it is almost unknown[24] to what extent the design of an OA_m impacts its efficacy, the present study shows that, compared to CPAP tritation, the DIORS® may be a good alternative to CPAP non-adherent patients (Table 2), providing significant objective and subjective improvements.

Despite being considered a gold-standard therapy for moderate to severe OSA,[25,26] efficiently reducing AHI,[24,26,27] some authors[2] criticize the CPAP concept due to its low adherence. Therefore, sleep physicians should monitor treatment adherence, and offer the oral appliance for OSA[27] treatment to patients who do not adhere to CPAP therapy. This study demonstrates an alternative solution for that problem.

Many circumstances make AHI a controversial value, since it relies on the duration of events, temporal position of the events (NREM vs REM), or even especial conditions (chronic lung diseases, for instance). For that reason, additional parameters were used to better define severity in the present data sample. Hence, together with AHI and Oxygen Saturation, the results here discussed regarding the arousal index — this is considered an important parameter not only because it is an alternative criterion for scoring hypopneas, but also because it is important in the sum of total sleep duration, which is directly related to either sleepiness and cardiometabolic risk in OSA patients.

Although BMI has significantly increased in the DIORS® therapy, actual parameters demonstrate a relevant improvement of respiratory (AHI and O_2Sa) and AI (Table 2) parameters. As the main objective of the therapy, such results show good efficacy, as previously described for mild, moderate and severe OSA, supporting the use of DIORS® based on clinical practice evidence.[1-3,5,8-11,17,20,25,27] It also reestablished respiratory parameters to normal range (AHI < 5/h; $p = 0.0001$ and $O_2Sa_{mean} > 93\%$; $p = 0.0005$), restored sleep (AI < 10/h; $p = 0.0001$), and reduced daytime sleepiness (ESS; $p = 0.01$).

The philosophy of the NOR[15,16] and gnathological school[13,14] advocate that the CP is the best reference plane for the occlusal rehabilitation because it promotes functional stability during stomatognathic functions. The DIORS® design respects the same principles, in search for a better OAT adherence, with stability and neuromuscular balance, providing a good prognosis and successful treatment outcomes.

Previous studies[28,29] report on objective and subjective adherence data, showing that the adherence of OA_m was about 83% when objectively evaluated, and 92% when subjectively assessed. In the present study, the DIORS® had no objective measure to evaluate adherence, justifying the use of a questionnaire to obtain data of adherence and symptoms. In Table 3, due to patient comfort and tolerance,[27] the monitoring data demonstrate 88.23% of DIORS® adherence showing a slightly higher percentage than in previous OA_m studies.

Regarding DIORS® safety, resistance, and durability[1,24], this research showed its stability and efficacy. This OA_m was able to maintain airway patency at a therapeutic level of protrusion, being only one fracture noticed in the advancement mechanism, with 95% of safety and resistance.

Finally, for a better treatment outcome,[1,7,24,27,30] a sleep doctor and a dental surgeon should compose the multidisciplinary team.

CONCLUSION

The present study provides an opportunity to investigate the factors likely to determine how to manufacture the OA_m and how to assess if its design significantly changes neuromuscular responses, prognosis and treatment outcomes.

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Changes in nasal septum morphology after rapid maxillary expansion: a Cone-Beam Computed Tomography study in pre-pubertal patient

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Introduction: Nasal septum deviation (NSD) is the most common structural cause of nasal obstruction, affecting around 65-80% of the adult population. Rapid maxillary expansion (RME) is currently used for treatment of maxillary transverse deficiency, but can also influence nasal cavity geometry.

Objective: The present study aimed at evaluating the changes in NSD by using Cone-Beam Computed Tomography (CBCT) scans in pre-pubertal patients treated with RME.

Methods: This retrospective exploratory study evaluated 20 pre-pubertal patients (mean age 10 ± 2 years) who were treated for transverse maxillary constriction with RME and presented mild/moderate NSD as an incidental finding. The outcome measures were NSD tortuosity and area. These measures were obtained from transverse and coronal views of records taken before and after RME treatment. Intra-rater reliability was also assessed with intraclass correlation coefficient.

Results: NSD was mild in thirteen patients (65%) and moderate in seven (35%). NSD tortuosity index did not significantly change over time (mean difference 0.002 mm/year, 95% CI; $p = 0.58$). NSD area did not significantly change over time (mean difference 2.103 mm^2/year, 95% CI; $p = 0.38$). Intraclass correlation coefficient was 0.73 (95% CI) for NSD tortuosity and 0.84 (95% CI) for NSD area.

Conclusions: NSD tortuosity and area suggested potential changes in NSD with small clinical relevance in pre-pubertal patients who were treated with RME. Additional studies using CBCT scans in larger samples are required to clarify the role of RME in NSD treatment.

Keywords: Nasal septum deviation. RPE. Rapid maxillary expansion. Maxillary transverse hypoplasia.

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

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INTRODUCTION

Nasal septum is an osteo-cartilaginous structure forming medial portion of nasal cavity, composed of septal nasal cartilage and perpendicular plate of the ethmoid bone and vomer bone. It is an important functional and esthetic structure for proper nasal respiration because it concurs to regulate airflow through the nose.[1] A straight nasal septum ensures a laminar airflow allowing the inspired air to be warmed, humidified and cleaned, in order to optimize the alveolar gas exchanges.[1,2] Inversely, a nasal septum deviation (NSD) concurs to nasal obstruction and impaired nasal respiration.[2] NSD is defined as a deflection from the midline, which can be caused by congenital deformation, traumatic/iatrogenic injury or important nasal infection.[3] NSD is the most common structural cause of nasal obstruction,[1] affecting around 65-80% of the adult population.[4,5] Although it is often physiological, NSD may require septoplasty surgical operation when it causes a severe grade of obstruction (≥ 16°).[6-8] This situation can also negatively affect the midfacial development in growing patients.[9] NSD is associated with many skeletal and dental problems, such as Class II malocclusion, increased overjet, retrognathic maxilla and mandible, increased anterior facial height, maxillary transverse deficiency associated with crossbite, high arched palate, low tongue posture and incompetent lips.[1,2,10]

The maxillary transverse deficiency is one of the most frequent problems in the craniofacial complex, causing usually monolateral or bilateral crossbite, crowding, high arched palate and mouth breathing.[11] Therefore, it is very important to identify and resolve this problem in children and adolescents. The most effective treatment is increasing maxillary width by using rapid maxillary expansion (RME), which is as a safe, reliable, tolerable, simple and predictable orthopedic procedure.[12,13] RME treatment aims to coordinate skeletal bases by opening the midpalatal suture, avoiding dental orthodontic effects as much as possible.[14]

Maxillary bones form the anatomical base of the nasal cavity, thus RME can influence nasal cavity geometry.[12,15] A recent systematic review[1] included only two studies with heterogeneous participants and results: Farronato et al.[15] reported NSD reduction in 94% of cases treated with RME, while Altug-Atac et al.[16] did not found any changes in NSD. The main weakness of these studies is the measurement using posteroanterior radiographs. Aziz et al.[17] evaluated NSD using Cone-Beam Computed Tomography (CBCT) scans and did not find any significant differences in NSD after treatment with RME in adolescents. However, using RME should be preferred before the pubertal peak of growth (CS1-CS3[18-20]) in order to achieve orthopedic rather than dental effects.[21]

Thus, the present study aimed at evaluating the changes in NSD by using CBCT scans in pre-pubertal patients treated with RME.

MATERIAL AND METHODS

Study design

This is a retrospective exploratory study. The study was conducted according to the Helsinki Declaration principles and patients gave their consent to have their data collected for scientific purposes. The study was approved by the local Ethics Committee of *Azienda Ospedaliera di Padova* (protocol # 41648).

Patients

Twenty patients treated with RME for maxillary transverse deficiency were included in the study (mean age 10 ±2 years). The inclusion criteria were: pre-pubertal patients (CS1-CS3[18-20]); skeletal maxillary transverse constriction with or without posterior crossbite; no previous orthodontic treatment; availability of pre- and post-treatment CBCT; NSD from mild to severe. Patients with congenital or dental anomalies and previous orthodontic treatment were excluded. NSD was discovered as an incidental finding in pre-treatment CBCT scans. Authors considered a control group, but it was not possible to collect pre- and post-treatment CBCT in patients without need of RME, for ethical limits. The CBCT scans were taken with the patient's head oriented in the same Cartesian plan.

Intervention

Each patient was treated with a Haas expander. The protocol of activation consisted in activation of the screw one-quarter turn twice a day for a variable period, depending on transverse constriction severity. Then RME expander was left in place for six months, for passive retention.

Figure 1 - Landmarks on sagittal view.

Image analysis

NSD was identified analyzing transverse and coronal views of CBCT records taken before RME treatment.[2] NSD was considered mild (≤ 8°), moderate (from 9° to 15°) or severe (≥ 16°).[6,7] All CBCT scans were taken with Soredex Scanora 3D (PaloDEx, Tuusula, Finland) before the beginning of the treatment (T_1) and after at least 12 months following the treatment (T_2). Images were converted into DICOM format, with a voxel size of 0.25 mm, and uploaded to Horos Project (v. 2.4.1, 64 bit) which is a free, open source medical image viewer (*https://horosproject.org/about/*). Landmarks were identified in the 3D viewer and 2D orthogonal mode in Horos Project for each patient in sagittal view, according to previous studies[16,22] (Figs 1 to 3). These landmarks were used to identify three axial (A1, A2, A3) and four coronal DICOM

Figure 2 - Landmarks on axial view.

Figure 3 - Landmarks on coronal view.

landmarks (C1, C2, C3, C4) for each patient at each time point. The axial landmarks included: the anterior point of nasal bone (A1), the junction of perpendicular plate of ethmoid bone and vomer (A2), and the midway point between A2 and C2 (A3). The coronal view included: the anterior point of nasal bone (C1), the anterior nasal spine (C2), the midpoint of crista galli (C3), the junction of perpendicular plate of ethmoid bone and vomer (C4). All measurements were repeated three times with seven days interval. Fourteen images were evaluated in each patient and were transferred to Matlab (MathWorks R2017b, Natick, Massachusetts) for NSD analysis. Data on NSD from Matlab were transferred to statistical software for data analysis.

Outcome measures

The outcome measures were NSD tortuosity and NSD area. NSD tortuosity was calculated as the ratio of length of the curve to the length of an imaginary line in the midsagittal plane, according to previous studies[16,22]. NSD area was calculated as the integral from the curve to an imaginary line in the midsagittal plane, according to previous studies.[16,22]

Statistical analysis

Continuous data were expressed as mean and standard deviation (SD). Intra-rater reliability was assessed with intraclass correlation coefficient (ICC) and 95 per cent confidence interval (CI).[23] The average of the three measurements at each time point (T_1 and T_2) was calculated for each subject and used for further analysis. Given the different length of follow-up among patients, the variations in NSD tortuosity and in NSD area were calculated as the difference over time (i.e., T_2-T_1) divided by the length of follow-up in each subject. Variations over time were evaluated using paired Student *t*-test and expressed as mean difference (MD) with 95 per cent confidence interval (95% CI). Association of NSD variations over time with age and width of expansion was evaluated using Pearson correlation coefficient. All tests were 2-sided and a *p*-value of less than 0.05 was considered statistically significant. Statistical analysis was performed using R 3.3 (R Foundation for Statistical Computing, Vienna, Austria).[24]

RESULTS

The study included 20 pre-pubertal individuals: NSD was mild in 13 patients (65%) and moderate in 7 patients (35%). Crossbite was observed in six patients (30%). Median width of expansion was 6.4 mm (SD = 0.8). Mean follow-up was 2.5 years (SD = 0.6).

ICC was 0.73 (95% CI = 0.60 to 0.86) for NSD tortuosity and 0.84 (95% CI = 0.75 to 0.92) for NSD area. NSD tortuosity did not significantly change over time (MD = 0.002 mm/year, 95% CI -0.005 to 0.008; $p = 0.58$). NSD area did not significantly change over

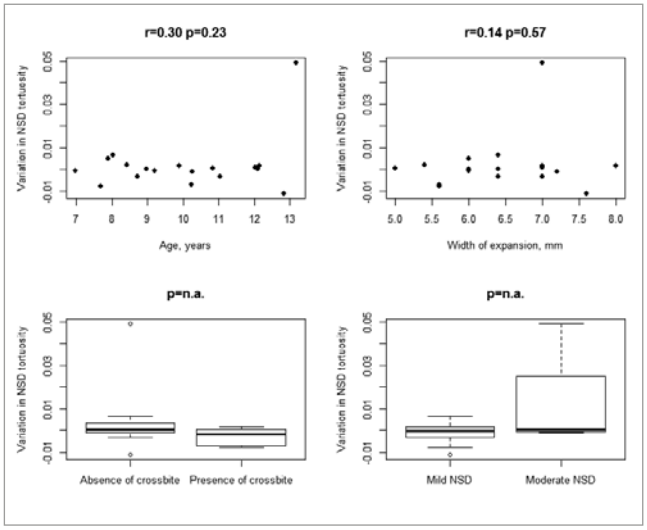

Figure 4 - Variation in NSD tortuosity (mm/year) according to age, width of expansion, presence of crossbite and NSD severity (n.a.= not available).

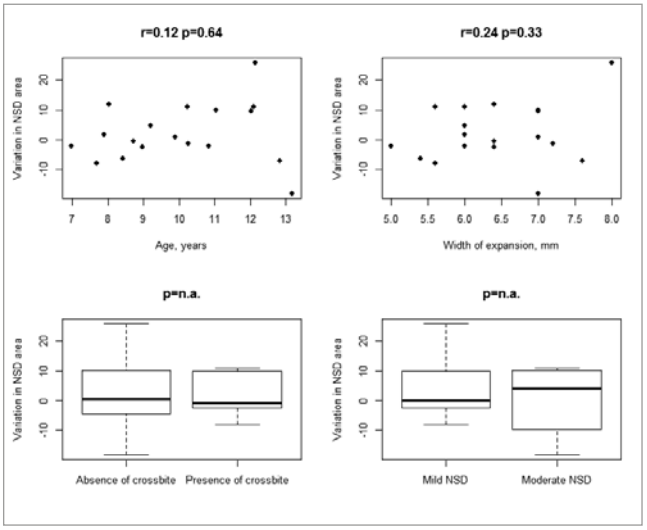

Figure 5 - Variation in NSD area (mm^2/year) according to age, width of expansion, presence of crossbite and NSD severity (n.a.: not available).

time (MD = 2.103 mm²/year, 95% CI -2.283 to 7.039; $p = 0.38$). Pre-treatment age and width of expansion were not associated with NSD tortuosity or NSD area (Figs 4 and 5).Graphical summary of NSD tortuosity and NSD area according to presence/absence of crossbite and NSD severity (mild/moderate) is shown in Figures 4 and 5. The limited sample size did not allow any meaningful statistical comparisons regarding crossbite and NSD severity.

DISCUSSION

NSD is the most common structural cause of nasal obstruction and it is a prevalent problem among the general population.[1,4,5] Surgical treatment is usually performed in patients reporting symptomatic nasal obstruction associated with NSD, while a deviated septum without other symptoms is not an indication for septoplasty.[8,25] RME is currently used for treatment of maxillary transverse deficiency, but can also influence nasal cavity geometry because maxillary bones form the anatomical base of the nasal cavity.[12,15] To our knowledge, few data on the effect of RME on NSD are available in literature.

The present data did not show any significant variations in NSD at long-term follow-up in prepubertal patients treated with RME. Although the limited sample size could affect statistical significance, the estimates of tortuosity and area nevertheless suggested potential changes in NSD with small clinical relevance. The present findings were in agreement with a previous study evaluating NSD in adolescents by using CBCT scans.[17] Aziz et al.[17] did not report any significant effect of RME in adolescents who were treated for mild to severe NSD. Other two studies investigated RME in NSD by using posteroanterior radiographs.[15,16] Farronato et al.[15] reported NSD reduction in children aged 5-9 years treated with RME, while Altug-Atac et al.[16] confirmed no effect of RME in NSD in adolescents. Available studies in literature present high heterogeneity regarding included participant age (children and adolescents), deviation degree (from mild to severe) and assessment tool (CBCT scans or posteroanterior radiographs). In addition, posteroanterior radiographs do not allow a good evaluation of anatomical measurements because of the overlap of the different anatomical structures.

CBCT scans are among the suggested diagnostic tools for NSD because it provides an accurate evaluation of anatomical measurements and allows a comprehensive assessment of deviation-related respiratory problems.[2] The present data showed good reliability of CBCT scans in identification of anatomical landmarks, in agreement with Aziz et al.[17]

RME is a beneficial procedure in the resolution of maxillary constriction but also in the treatment of nasal respiratory problems.[12,26] The opening of the midpalatal suture allows significant widening of maxillary bone and increasing of intranasal cavity. Moreover, the increase in nasal cavity width is associated with lowering of the palatal vault that reduces nasal resistance, ensuring a better nasal airflow.[26-28] This effect leads to a marked improvement in nasal breathing with also a remarkable stability of the increments of nasal dimensions in the long-time period.[27,28] Such improvements are likely to be associated with the increase in area and volume of the nasal cavities rather than with changes in the nasal septum morphology.

The strengths of the present study included NSD evaluation by using CBCT scans and the inclusion of pre-pubertal patients. CBCT scans can provide more reliable identification of landmarks with respect to posteroanterior radiographs.[1] Moreover, using RME should be preferred before the pubertal peak of growth (CS1-CS3[18-20]) in order to achieve more effective long-term orthopedic effects.[21] Although the mechanism regulating the development process has not been fully clarified, the septal cartilage has been suggested to play a main role in the down-forward repositioning of the nasomaxillary complex[29] together with the soft tissue stimulus.[30]

This study has some limitations. First, it is a retrospective study and post-treatment evaluation was available at different time points. However, we calculated changes in NSD divided by the length of follow-up in each patient. Second, there was no control group, because RME is currently used for maxillary transverse deficiency and all patients with maxillary transverse deficiency were treated with RME. Third, the limited sample size did not allow any meaningful statistical comparisons according to presence of crossbite and NSD severity. These limitations are suggestions that could be considered for further researches.

CONCLUSIONS

NSD tortuosity and area suggested potential changes in NSD with small clinical relevance in pre-pubertal patients who were treated with RME. Additional studies using CBCT scans in larger samples are required to clarify the role of RME in NSD treatment.

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Importance of orthodontic intervention of the Class III malocclusion in mixed dentition

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Introduction: Supervising the development of occlusion, managing problems during the transition from mixed to permanent dentition, as well as controlling environmental factors that contribute to establishing malocclusion, are important actions to achieve a Class I occlusion with facial balance. Among these problems, the malocclusions associated with dysfunctions such as mouth breathing or obstructive sleep apnea syndrome (OSAS), atypical swallowing and abnormal tongue position, open bites, crossbites and maxillomandibular discrepancies, and especially the Class III malocclusion can be listed.

Objective: The purpose of this article is to present and discuss the main aspects relevant to the benefits of performing the treatment of Class III malocclusion in patients with growth.

Keywords: Interceptive orthodontics. Corrective orthodontics. Malocclusion.

INTRODUCTION

Supervising the development of occlusion, managing problems during the transition from mixed to permanent dentition, as well as controlling environmental factors that contribute to establishing malocclusion, are important actions to achieve Class I occlusion with facial balance, which often does not occur naturally without interceptive orthodontic treatment. Orthodontic approaches may be related to different categories of problems, such as a malocclusion in development, in which it may be necessary to intervene to reduce or interrupt the unfavorable change;[1] or a dentition whose normal development can be interrupted by some local etiological factor, which requires treatment to maintain or restore the appropriate development.[2]

Some of the most relevant objectives of supervising the development of occlusion are to properly manage the growth potential in order to intercept skeletal imbalances, eliminate functional deviations, improve self-esteem, minimize trauma and prevent periodontal problems.[3] The possible advantages of the early intervention are the emotional satisfaction of the child, the growth potential available at this stage

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

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of development, greater collaboration with treatment, the possibility of a more simplified second phase and the possible reduction of extractions in the corrective phase of treatment. Disadvantages also exist, such as inefficiency, longer treatment time, immaturity of the patient, inefficient oral hygiene, inability to care for the devices and cost.

The ideal age to treat malocclusions in growing patients has been a widely discussed and controversial topic. One of the most important debates is to stop the development of problems with early treatment or to delay therapy. Among these problems, the malocclusions associated with disorders such as mouth breathing or obstructive sleep apnea syndrome (OSAS), atypical swallowing and abnormal tongue position, open bites and crossbites, and maxillomandibular discrepancies, and especially the Class III malocclusion can be listed.

Class III malocclusion is a condition that can be classified as dentoalveolar, skeletal or functional, and its etiology will determine the diagnosis and prognosis of treatment.[4] This malocclusion must be intercepted early, preferably during the deciduous dentition phase, since Class III tends to exacerbate itself during growth, especially during adolescence.[4-6] The sooner treatment is started, the greater the compensatory orthopedic effects of the inevitable orthodontic discrepancies, which can often prevent need for orthognathic surgery at the end of growth. In addition, the early treatment of Class III brings psychological benefits, due to the improvement of facial aesthetics that also implies in the improvement of self-esteem.[5,6]

Long-term studies of early treated Class III malocclusions reveal that the results of the treatment are stable, with visible improvement in facial profile, occlusion and masticatory functions.[4,6] Maxillary protraction therapy with a facemask is the most common treatment for patients with skeletal Class III due to maxillary retrusion, as it stimulates maxillary advancement and assists in the control of mandibular development.[7] As this type of treatment must be started early, the anchorage is performed on permanent and/or deciduous teeth, stimulating the movement of the maxilla forward, rotating the mandible down and back, and decreasing the rotation of the palatal plane. There is also the projection of the upper incisors, mesialization and extrusion of the upper molars and the retroinclination of the lower incisors.[4-7]

In addition to the anteroposterior skeletal discrepancy, it is common to find other malocclusions associated with Class III due to maxillary hypoplasia, such as posterior crossbite and anterior open bite. Once the muscular balance is compromised by the negative overjet, habits such as the anteriorization of the tongue on swallowing and phonation are perpetuated during the child's development, changing the muscle tone, the posture at rest, and consequently establishing the anterior open bite.[4,6,8,9] It is for this reason that the interception of oral habits and multiprofessional treatment is essential for the stability of the results obtained with orthopedic and orthodontic therapy.[4,8,9]

Therefore, the objective of this article is to present and discuss the main relevant aspects of the benefits of carrying out the supervision of the development of the occlusion, in addition to describing the interceptor and corrective orthopedic and corrective treatment of a patient with growing Class III malocclusion (case report presented to the Brazilian Board of Orthodontics and Facial Orthopedics).

CASE REPORT

Male patient, at the end of the first transitional period of mixed dentition, aged 8 years and 4 months, with good general health and without carious lesions or periodontal problems. During the initial consultation, the patient reported as the main complaint *"the lower part is crossed and developed"*, in addition to the practice of parafunctional habits.

Upon extraoral examination, the patient's face revealed typical characteristics of Class III malocclusion, with a deficiency of the middle third of the face, without zygomatic projection, showing the sclera in the lower part of the iris and active lip sealing. In frontal view, there was a slight facial asymmetry with mandibular deviation to the right, while in lateral view it showed a concave profile, with a chin-neck line apparently adequate to the face size (Fig 1). During the anamnesis and initial examination, the parafunctional habits of lingual interposition in phonation, adapted swallowing and tongue hypotonia were found.

The intraoral analysis showed an Angle Class I dental relationship, maxillary hypoplasia, bilateral posterior crossbite, anterior crossbite with a -6 mm

overjet, anterior open bite of 7 mm and inverted lower Spee curve. In addition, there was a severe lack of space of -8 mm in the upper arch to the lateral incisors irruption, biprotrusion and diastema between the upper central incisors. Despite the slight mandibular deviation to the right and the existence of diastemas, the upper and lower midlines were coincident (Fig 2).

In the initial panoramic radiographic examination, it was observed the impaction of upper lateral incisors, with their roots in the developmental stage 8 of Nolla. The lack of space for the irruption of upper canines was also noticed, while the other permanent teeth had normal development and positioning (Fig 3). The lateral teleradiography of the face showed excessive vestibular inclination of the upper and lower incisors, maxillary hypoplasia, mandible with adequate size and position, and relatively short cranial base (Fig 4).

Steiner's cephalometric analysis revealed a growth tendency of Class III (SNA=80°, SNB=80° and ANB=0°), while Wits[10] analysis (-4 mm) showed a real Class III. The patient had a horizontal growth pattern (Y axis=54°, FMA=22° and SN.GoGn=31°) and dental biprotrusion confirmed by measurements 1.NA=29°, 1-NA=6 mm, 1.NB=35°, 1-NB=8mm and $\underline{1}.\overline{1}$=114° (Table 1).

TREATMENT PLAN

A two-stage treatment was suggested due to the type of malocclusion. The first stage was the orthopedic treatment with palatal disjunction, maxillary protraction and interception of the parafunctional habit; and the second, the corrective orthodontic treatment with fixed appliances.

For the first phase of treatment, a modified Haas appliance was planned, with vestibular hooks, anchored on the deciduous second molars with a protocol of activation twice a day (morning and night),

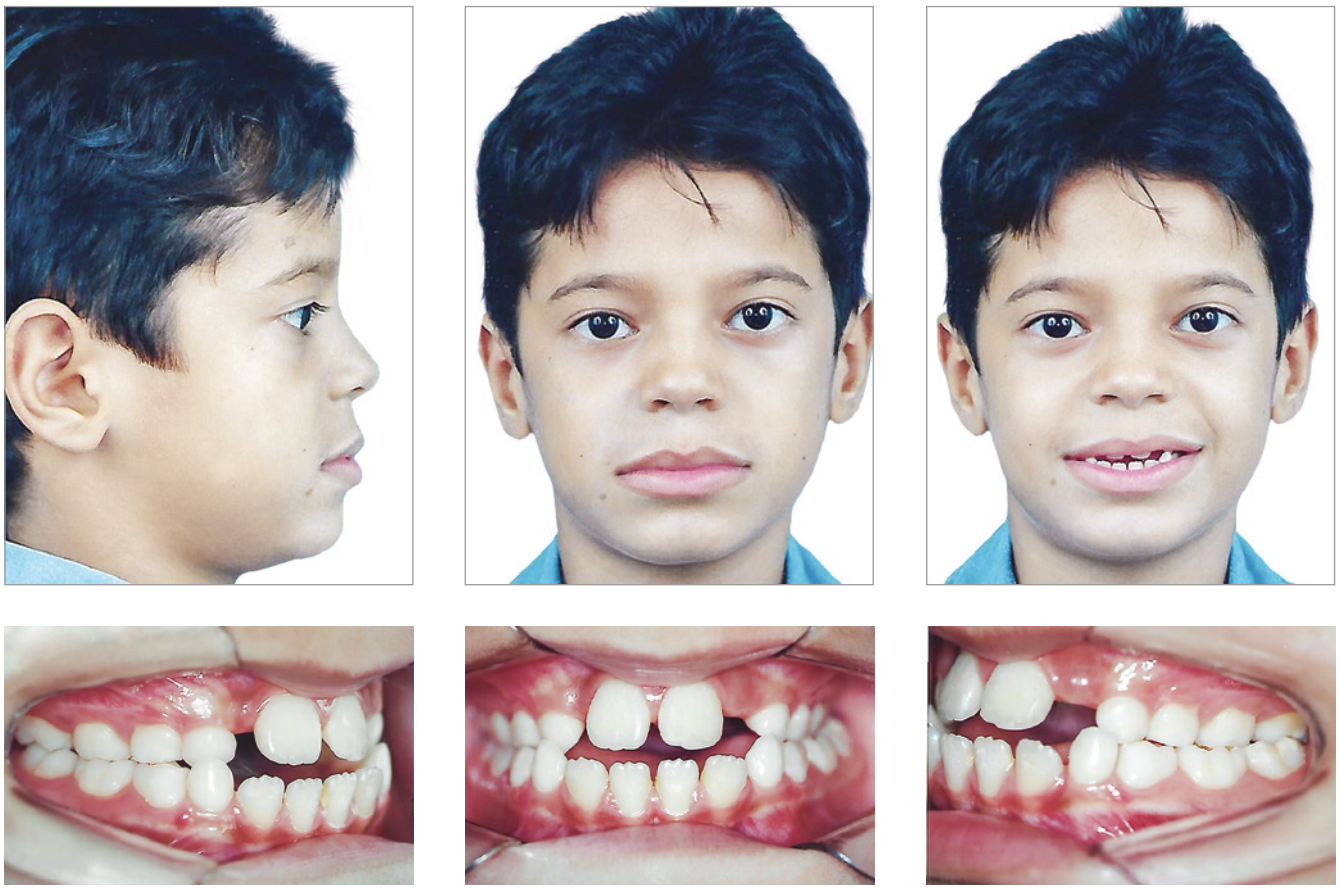

Figure 1 - Facial and intraoral initial photographs.

Figure 2 - Initial panoramic radiograph.

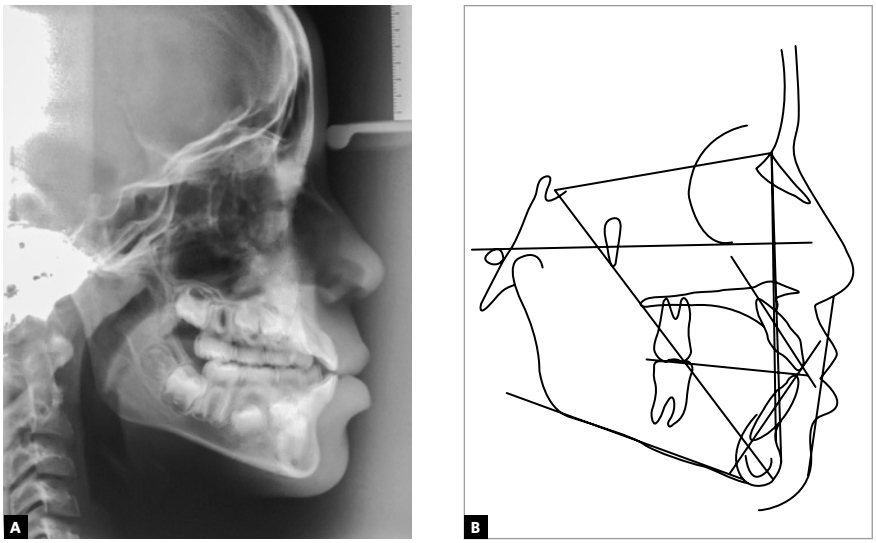

Figure 3 - Initial cephalometric radiograph (**A**) and cephalometric tracing (**B**).

for 10 days or until overcorrection of the posterior crossbite. Petit's facemask was installed, with 500gF on each side and daily use of at least 16 hours. A lingual arch with spurs was also placed to intercept the tongue interposition habit. The maxillary protraction mechanics was actively conducted for approximately one year, a period necessary for the overcorrection of the anteroposterior discrepancy, and after this period, another six months of night use to preserve the results obtained. Spurs welded to the lingual arch were maintained during the second phase of treatment, until the correction of the anterior open bite, at which point the patient was referred for speech therapy.

The second phase of the treatment consisted of the corrective orthodontics, with the use of a Roth prescription (0.022 x 0.028-in) fixed metal appliance. A 4x2 mechanics was adopted in order to correct the Spee curve of the lower arch. After the initial alignment and leveling, Class III intermaxillary elastic mechanics (3/16-in, medium strength) and intercuspation mechanics with 1/8-in medium strength elastics in a 0.019 x 0.025-in braided stainless steel wire were applied. A removable wraparound retainer was planed for the upper arch, and a fixed 3x3 lingual bar, made with 0.018-in twisted flex wire, and maintained indefinitely for the lower arch.

RESULTS

At the end of the treatment, the initial objectives were achieved, with a visible improvement in the facial profile and anteroposterior relationship of the face (Fig 5). A Class I of molars and canines was obtained, correction of the Spee curve, correct transversal relationship between the arches and adequate overbite and overjet (Fig 6). With the association of orthopedic and orthodontic mechanics it was possible to redirect the craniofacial growth, obtaining a Skeletal Class I relationship (ANB = + 2° and Wits = +1 mm) (Table 1, Figs 7, 8, 9 and 10). Thus, adequate functional guides and correct posture and tonus of the tongue were established.

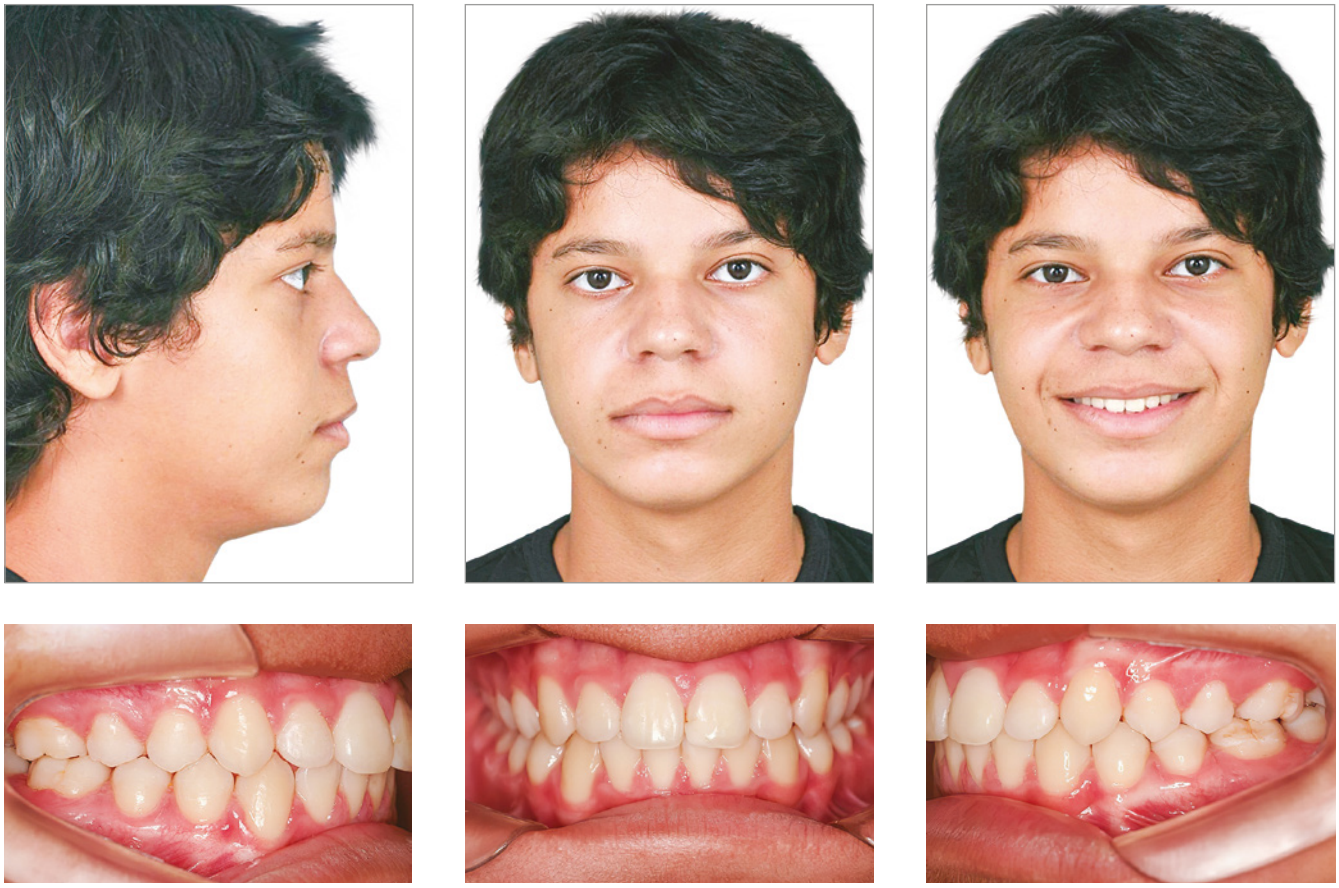

Figure 4 - Facial and intraoral final photographs.

Figure 5 - Final panoramic radiograph.

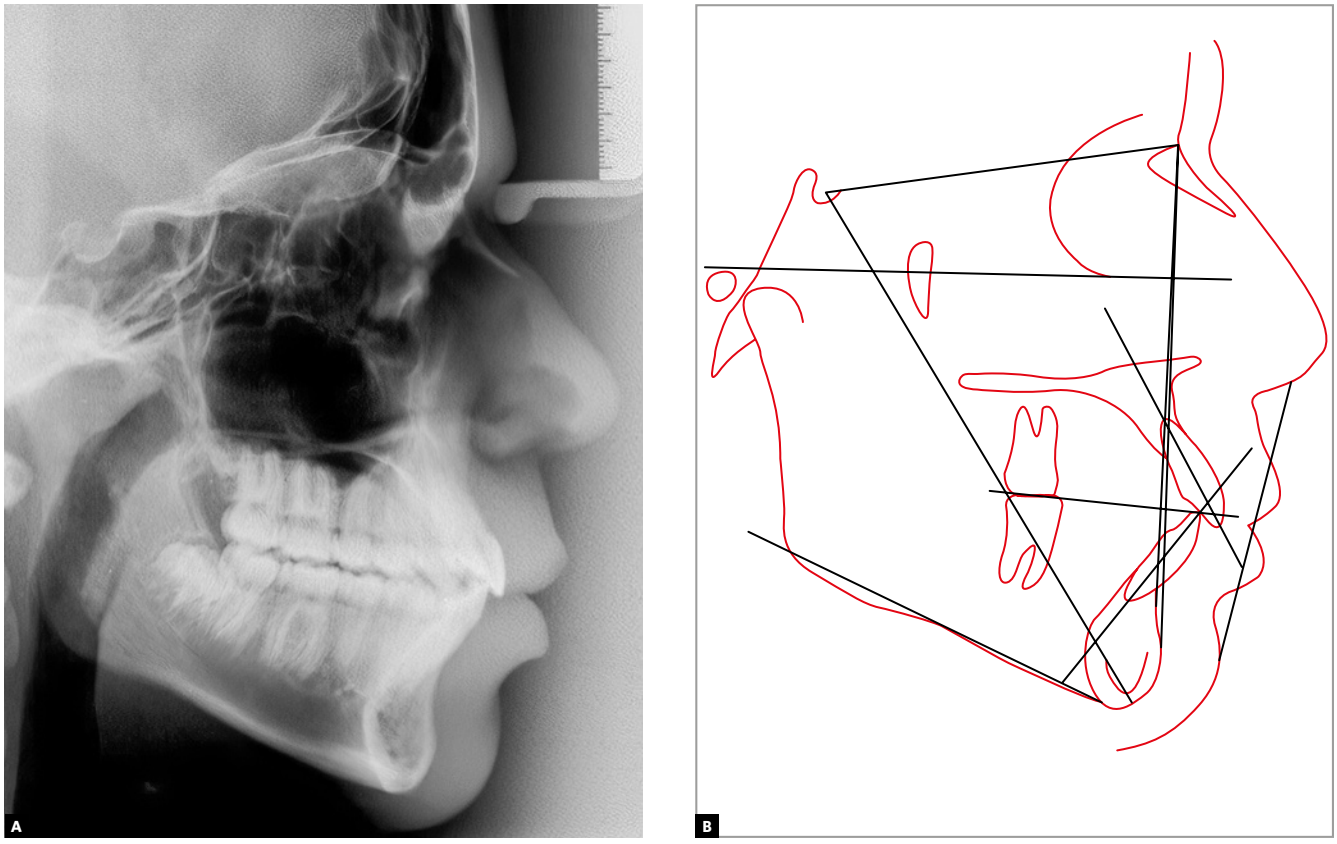

Figure 6 - Final cephalometric radiograph (**A**) and final cephalometric tracing (**B**).

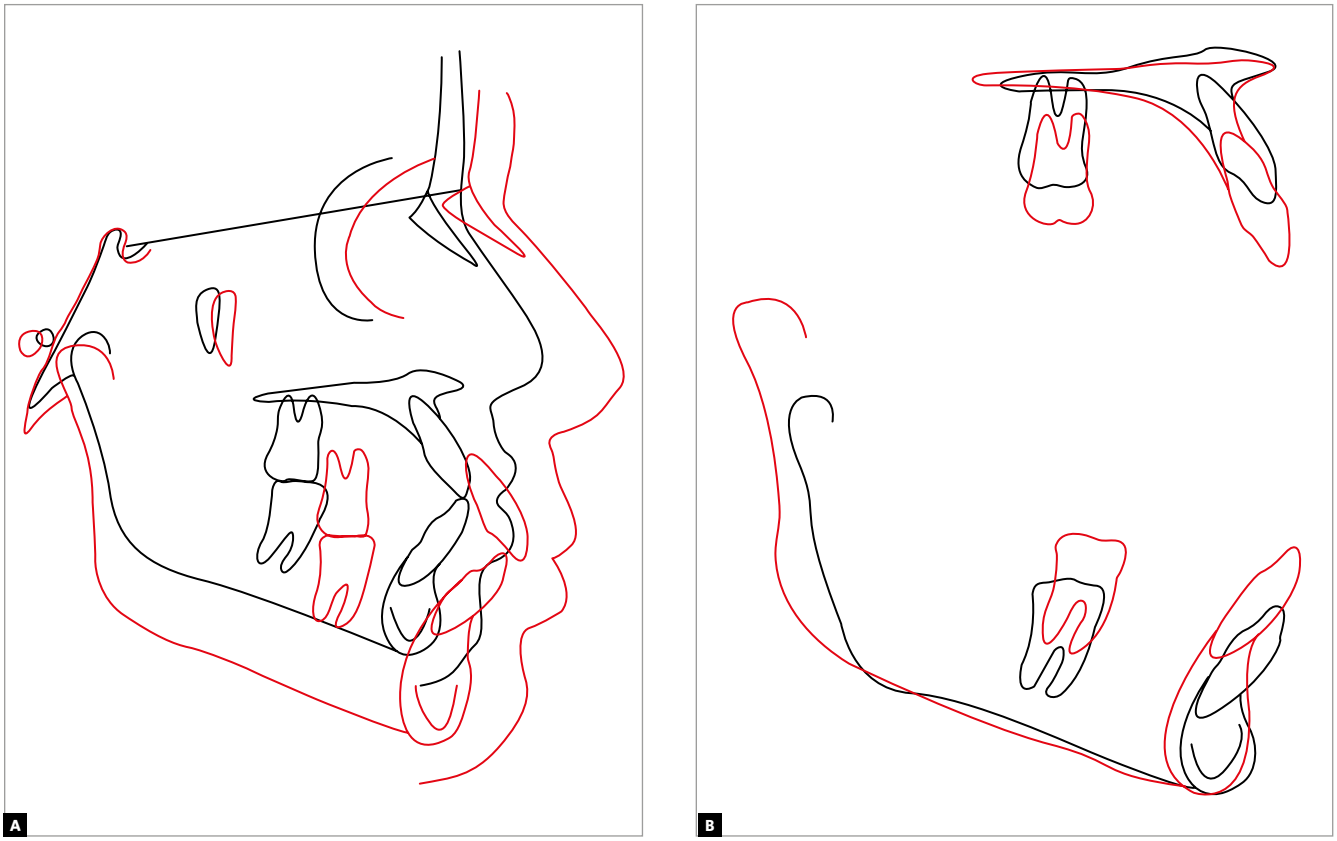

Figure 7 - Total (**A**) and partial (**B**) overlays of the initial (black) and final (red) cephalometric tracings.

Table 1 - Comparison of the initial and final cephalometric measurements of the patient.

	Measurement		Normal	A	B	Dif. A/B
Skeletal pattern	SNA	(Steiner)	82°	80°	80°	0
	SNB	(Steiner)	80°	82°	82°	0
	ANB	(Steiner)	2°	0°	2°	2
	Wits	(Jacobson)	♀ 0 ± 2mm ♂ 1 ± 2mm	-4mm	+1mm	5
	Angle of Convexity	(Downs)	0°	0°	2°	2
	Eixo Y	(Downs)	59°	54°	58°	4
	Facial Angle	(Downs)	87°	90°	88°	2
	SN.GoGn	(Steiner)	32°	31°	34°	3
	FMA	(Tweed)	25°	22°	25°	3
Dental pattern	IMPA	(Tweed)	90°	105°	102°	3
	1.NA (graus)	(Steiner)	22°	29°	27°	2
	1-NA (mm)	(Steiner)	4mm	6mm	8mm	2
	1.NB (graus)	(Steiner)	25°	36°	35°	1
	1-NB (mm)	(Steiner)	4mm	8mm	8mm	0
	$\frac{1}{1}$ - Interincisal Angle	(Downs)	130°	114°	114°	0
	1 - APg	(Ricketts)	1mm	7mm	8mm	1
Profile	Upper lip-S line	(Steiner)	0	3mm	3mm	0
	Lower lip-S line	(Steiner)	0	5mm	4mm	1

DISCUSSION

The assessment and treatment of occlusal and skeletal disharmonies can be initiated at various stages of development, depending on the severity, the pattern of skeletal growth, as well as the risks and benefits of treatment itself. Early treatment is definitely a viable possibility; however, it is not indicated for all patients. The objectives of the early orthodontic intervention include controlling unfavorable growth, preventing aggravation of dental and skeletal disharmony, improving occlusion and aesthetics of the smile. Therefore, it is recommended to supervise the development of the occlusion throughout the tooth eruption process in order to offer treatments with more predictable results. In this Class III clinical case, the interceptive approaches to deleterious oral habits together with the early orthopedic treatment of malocclusion, were determining factors for the treatment outcome.[11-21]

Some malocclusions, such as crossbites, do not correct themselves and tend to worsen during the child's growth and development. Therefore, they should be treated as soon as they are diagnosed. There are several reasons for starting treatment in the early stages of mixed dentition: taking advantage of bone bioelasticity; prevent joint disorders; redirect growth towards the normal development of facial and skeletal characteristics; prevent dental disharmonies from evolving to skeletal ones, and improve the breathing pattern in children with mouth breathing or OSAS. In this period, the correction of skeletal changes is simpler and with a lower biological cost for the patient, as in the case of correction of the posterior crossbite by means of disjunction of the median palatal suture. In children aged 8 to 10 years, this palatal suture is wide and with more regular edges, whereas in later periods of growth (10 to 13 years) this suture becomes more irregular and juxtaposed.[22]

The best moment to start treatment in patients with skeletal Class III associated with maxillary retrusion has been widely discussed by studies supported by clinical observations. The periods of primary dentition and the first transitional period of mixed dentition, around 6 years of age, are the most propitious to initiate maxillary protraction, since the orthopedic effects are more expressive, with significant advances in points A and ANS (anterior nasal spine)[5,23].

In these periods there is a greater predisposition to anterior displacement of the maxilla, increasing the growth in the maxillary and circummaxillary sutures, which are regular and wide before 8 years of age and become more strongly interdigited near puberty.[2] In the initial stage of mixed dentition, the best orthopedic responses are observed in the correction of posterior skeletal crossbite,[24] anterior open bite,[25] and skeletal Class III.[1]

The therapeutic decisions made for the first phase guaranteed the results obtained at the end of the entire treatment. The indication of lingual spurs is presented in the literature as a valid therapeutic modality to eliminate the habit of interposing and reeducating the tongue posture, contributing to the correction of the anterior open bite.[11,15,26-30] For this reason, immediately after the disjunction of the maxilla, the lingual arch with welded spurs was installed. So that, without the interference of the tongue, the correction of the anterior open bite occurred simultaneously with the effects of the treatment with the facemask that redirected the maxillary growth forward and down.

The decision for maxillary protraction was based on evidence proven by literature that the Class III treatment with the facemask is the most widely chosen for the correction of the retrognathic maxilla.[13,17] Studies show significant favorable results in the correction of dental and skeletal variables, such as positive changes in the Wits analysis indexes and in the correction of the patient's overjet.[5,17,31] These previously reported characteristics corroborate the results of this clinical case, which culminated in the improvement of Wits analysis values from -4 mm pretreatment to + 1 mm after treatment, and adequate overjet and overbite.

The protocols adopted for maxillary protraction of this patient are also in accordance with those stated by the scientific literature, such as previous maxillary disjunction[5,17,31-33] followed by protraction of the maxilla with an approximate direction of 30° downwards and forwards, and magnitude of force between 300gF and 600gF per activation side.[5,31-35] This first phase of treatment promoted a more favorable environment for the expression of facial growth and development, correcting occlusal relationships, improving facial aesthetics and self-esteem, and minimizing permanent skeletal deformations in the adult phase.[19]

Therefore, the treatment of Class III performed during the growth period promoted positive results. However, the hereditary character of this malocclusion can compromise the results obtained with early treatment, making more invasive treatments such as orthognathic surgeries necessary, if the patient is not properly monitored orthodontically until the end of his growth. Thus, it is important that the treatment of Class III is carried out in two stages, the first stage of interception, with orthopedic and functional treatment, and the second stage, of orthodontic treatment with fixed appliances, for the refinement of occlusal relationships, with use of Class III intermaxillary elastics for the consolidation of Class I obtained after maxillary protraction therapy.[17]

CONCLUSION

The intervention and supervision of skeletal Class III performed in patients before the growth spurt, associated with the interception of deleterious oral habits and effective and efficient orthodontic mechanics are decisive factors for the success of orthodontic treatment of this malocclusion.

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Conception or design of the study: DBHS, ASG. Data acquisition, analysis or interpretation: DBHS, ASG. Writing the article: ASG. Critical revision of the article: DBHS, ASG. Final approval of the article: DBHS, ASG.

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Treatment of bimaxillary protrusion using intra- and extra-alveolar miniscrews associated to self-ligating brackets system

Henrique Mascarenhas **Villela**[1]

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Introduction: Moderate and severe bimaxillary protrusion impair the passive lip sealing and the facial and smile esthetics. The extraction of premolars can be avoided by the use of skeletal anchorage to retract both dental arches. This approach brings many advantages such as: prevents premolars extraction; simplifies orthodontic mechanics; there is no volume reduction of a premolar when smiling; control of overbite and gingival exposure. The utilization of this therapeutic approach, when associated with self-ligating brackets, can bring the possibility of spacing the appointments without damage to the treatment efficiency, and allows selection of the most appropriate torque prescriptions for each case. The intra-alveolar miniscrews are indicated for mild cases of bimaxillary protrusion, while extra-alveolar miniscrews may also be indicated for more severe cases.

Objective: To report the treatment of three cases of mild, moderate and severe bimaxillary protrusion, in which intra- and extra-alveolar miniscrews were used, according to the retraction required.

Conclusion: The retraction of both upper and lower dental arches using orthodontic intra- and extra-alveolar miniscrews, associated with self-ligating brackets, is an excellent tool to correct mild to severe bimaxillary protrusion, thus reducing the need of premolar extraction and simplifying the orthodontic management.

Keywords: Extra-alveolar miniscrew. Intra-alveolar miniscrew. Mini-implants. Bimaxillary protrusion. Self-ligating brackets.

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

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INTRODUCTION

Patients with dentoalveolar bimaxillary protrusion usually present increase in incisor inclination, accompanied by lip protrusion, which may cause muscle imbalance with lip incompetence.[1,2] One of the premises to achieve a good facial esthetics is good positioning and shape of the lips.[3] The retraction of incisors, in this malocclusion, promotes reduction of their inclinations and improvement in soft tissues, altering the profile.[4,5] The amount of retraction of anterior teeth and movement of the lips are important factors to predict the change in facial profile after orthodontic treatment.[2,3]

Often, extractions of first premolars are indicated to provide space for anterior retraction and improve the inclination of incisors in their bone bases.[6,7]

Temporary anchorage devices (TADs), such as miniplates, can offer an excellent anchorage option for full retraction of the arch to correct crowding or protrusion.[8]

With the advent of orthodontic miniscrews, the possibility to promote tooth movements supported on fixed points in the oral cavity, minimizing undesired side effects, made the treatments more efficient and predictable, reducing the need for patient compliance and simplifying the orthodontic mechanics.[9-15] Orthodontic miniscrews can provide special benefits for the treatment of mild or moderate bimaxillary protrusion, such as the possibility of retracting the entire arch to reduce the incisor inclination, decreasing the indication of premolar extractions.[9,10]

Correction of mild bimaxillary protrusion can be achieved by full retraction of the arches in a single stage, using intra-alveolar miniscrews, which are placed in the region between first molars and second premolars. This positioning between the roots limits the amount of retraction, due to the little space available between roots in this area.[16] Other sites for placement of intra-alveolar miniscrews have been used to achieve more spaces for greater retractions, such as in the region between first and second molars or distal to the lower second molars.[9,17] Two-stage retraction, with intra-alveolar miniscrews, can also be used for retraction in corrections of more severe bimaxillary protrusion. This strategy consists of changing the screws, placing them more distally, when the second premolar root is close to the screw body.[18]

In 2007, Liou et al.[19] proposed a method for screw placement on the infrazygomatic crest (IZC), in the buccal region of first molars. These authors suggested a more inclined placement of the miniscrew, to allow greater sagittal correction without interference from the screw body with the mesiobuccal root of the upper first molar, which allows total retraction of the maxillary arch in a single stage.

In 2008, Villela et al.[20] used a titanium miniscrew in the region between upper first and second molars, with greater inclination in their placement, aiming at removing the screw body from the molar roots, which allowed greater retraction of the upper arch in a single stage.

Chang et al.[21-23] used extra-alveolar stainless steel screws, with larger diameter and length, in areas of denser cortex, both in the infrazygomatic crest region and in the mandibular buccal shelf, by the use of a distalization and retraction mechanics of the entire arch in a single stage. This strategy can be used to compensate Class II and Class III malocclusions and bimaxillary protrusion, reducing the indication of extractions.

Self-ligating brackets do not require the use of metallic or elastic ligatures to retain the orthodontic arch.[24] Self-ligating appliances have reduced friction compared to conventional brackets, since they do not require the use of ligatures.[25-28] Also, they promote a decrease in the accumulation of dental plaque, less injury to oral tissues, shorter chair time, and allow longer intervals between consultations.[29,30] As an aid in torque control, brackets with different prescriptions can have different torque values, which can be used individually for each type of orthodontic movement desired. The available prescriptions are high, low and standard torque.[24,31]

Thus, the objective of the present study is to demonstrate the efficiency of intra- and extra-alveolar miniscrews associated with self-ligating brackets in the treatment of mild, moderate and severe bimaxillary protrusion.

BIOMECHANICS USED FOR TOTAL RETRACTION OF ARCHES WITH ORTHODONTIC MINISCREWS

When performing full retraction of the arches, there is a tendency to rotation around their center of resistance, which is positioned between the premo-

lars, at the level of the middle third of roots, both in the maxilla and mandible. When the retraction is anchored on miniscrews, the line of force action passes more occlusally to the center of resistance. This line is determined by two points, which are the sites where the power elements are attached (hook and screw head). The effects of this retraction produce retroclination of incisors, with a tendency to extrusion, and distalization of posterior teeth, with a tendency to intrusion. In cases of bimaxillary protrusion in which extrusion of the upper incisors is not desired, it is important to use short anterior hooks. The head of miniscrews must be positioned closer to the mucogingival line, to produce an inclined line of force action and perform retraction with an intrusion component in the anterior teeth (Fig 1).

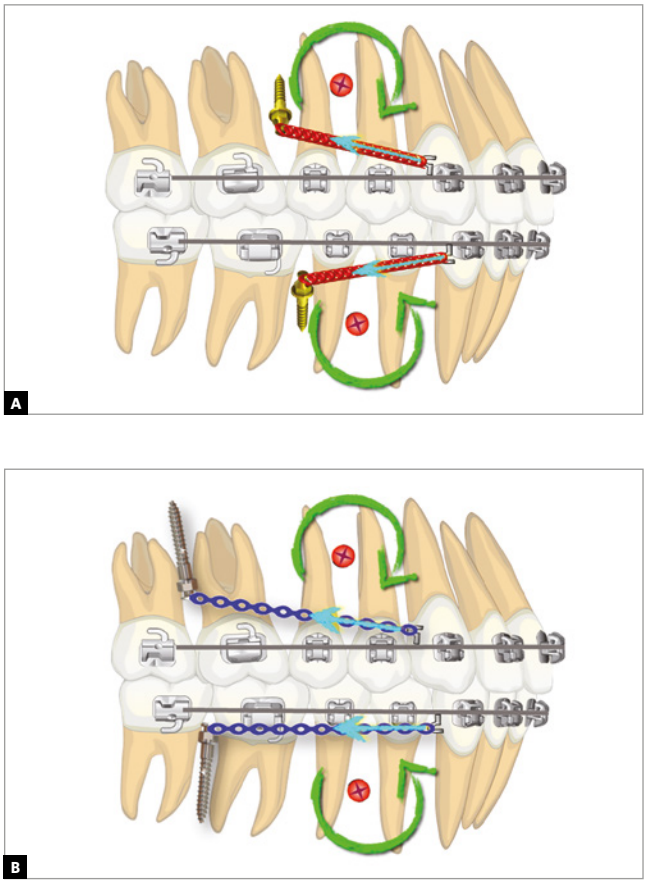

Figure 1 - Biomechanics of total retraction of the arches using intra-alveolar (**A**) and extra-alveolar (**B**) miniscrews.

CASE REPORTS

Three mesofacial patients will be presented, with balanced facial thirds, reduced overjet and overbite, lack of passive lip sealing and mild, moderate and severe bimaxillary protrusion, respectively, treated with self-ligating brackets associated with four orthodontic miniscrews. The mild bimaxillary protrusion was treated with intra-alveolar miniscrews; moderate and severe cases were treated with extra-alveolar screws.

CASE REPORT 1

Description and diagnosis

Female patient, aged 30 years, reported dissatisfaction with the protrusion of teeth and lips. The frontal facial analysis showed symmetry, balanced facial thirds, good proportion between facial height and width, characteristics of mesofacial individuals. The lateral facial analysis revealed a Pattern I face, with good convexity, well-positioned maxilla and mandible. Lateral evaluation of the lower facial third evidenced increased projection of the lips, which compromised the facial esthetics. Evaluation of smile revealed that the upper arch presented good exposure of the upper incisors and gingiva, with excess exposure of lower incisors and asymmetry of the lower lip. It also revealed a good vertical relationship between the upper incisors and upper lip (Fig 2).

Analysis of dental arches showed Angle Class I malocclusion, with excellent molar, premolar and canine sagittal relationships; however, with absence of the upper right first molar. Non-coincident upper and lower dental midlines were observed, due to deviation of the upper midline to the left because of a greater crowding of tooth #22 and contra-angulation of tooth #21. The overjet and overbite were reduced, due to the increased inclination of upper and lower incisors (Fig 3). The upper arch presented moderate crowding and rotation of teeth #11, #21 and #22. The lower arch presented good alignment and leveling, with presence of a fixed canine-to-canine retainer on the lingual aspect, due to a previous orthodontic treatment (Fig 3).

Analysis of the panoramic radiograph showed absence of the upper right first molar and upper and lower third molars. The other teeth and periodontal structures were in normal condition (Fig 4).

The initial cephalometric analysis revealed good positioning of the maxilla and mandible, slightly di-

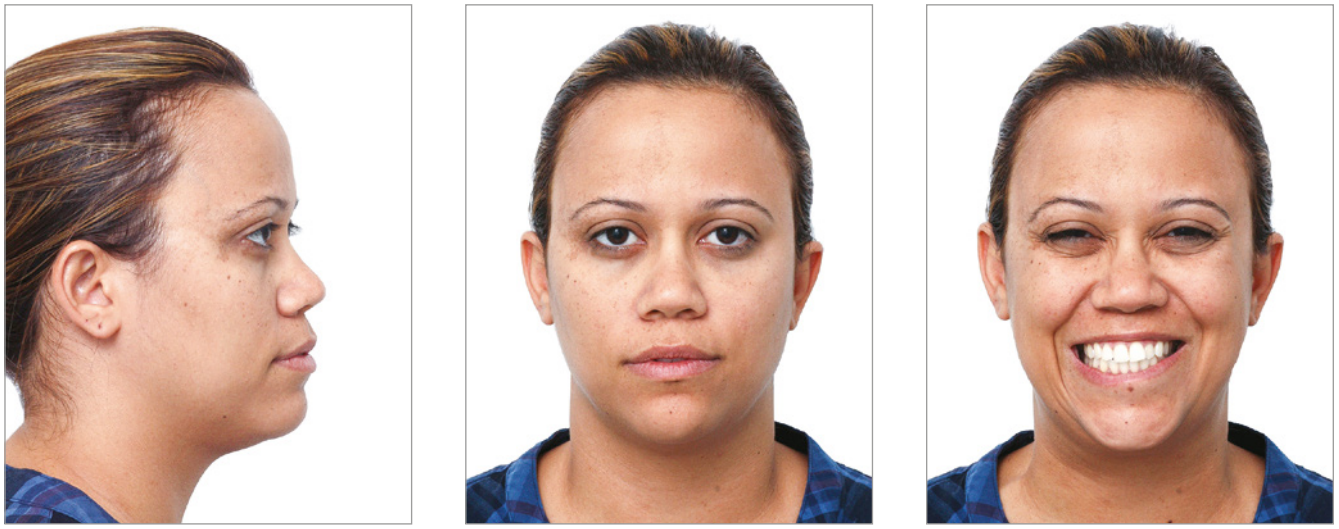

Figure 2 - Initial extraoral views.

Figure 3 - Initial intraoral views of the patient with Class I malocclusion, bimaxillary protrusion and reduced overjet and overbite.

vergent angles of the palatal, occlusal and mandibular planes, and normal lower facial height, characteristic of mesofacial individuals (Fig 5).

» The upper incisors had a slightly increased inclination (1.PP=115°). This angle assesses the relationship between the long axis of incisors and the palatal plane, with a mean normal value of 110°.

» The upper incisors had a good vertical relationship with the upper lip, with a FAOP (Functional Aesthetic Occlusal Plane) of 2.5 mm. The lower incisors required extrusion of 2.5 mm to touch the FAOP plane (FAOP=+2.5 mm/-2.5 mm). The FAOP evaluates the positioning relationship between molars, incisors and upper lip stoma[32]. The normal measure is 2.0 to 4.0 mm with the upper incisor. The lower incisor must be tangent to this plane.

» The lower incisors had a slightly increased inclination (IMPA=100°). This angle assesses the relationship between long axis of lower incisors and the mandibular plane, and the normal measure is 90°.

» Retromolar space is the space between the distal aspect of the crown of the lower second molar and the mesial aspect of the mandibular ramus. This space must be compatible with the need for distalization (Fig 6). There was good space in the retromolar region (RMR) to perform distalization of the lower arch.

Figure 4 - Initial panoramic radiograph.

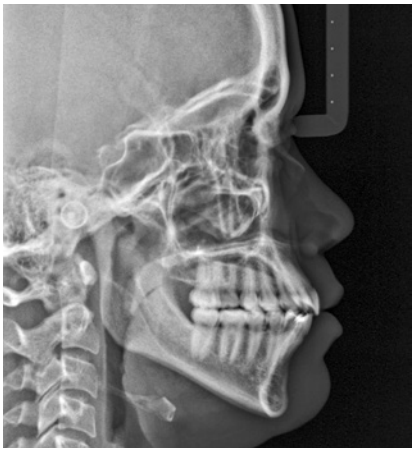

Figure 5 - Initial lateral cephalogram.

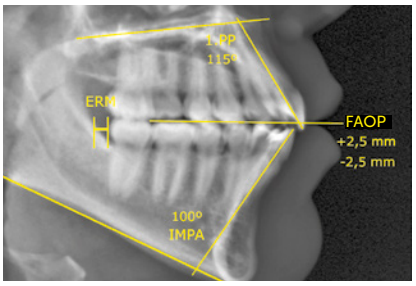

Figure 6 - Initial cephalometric measurements.

Treatment planning and mechanics employed

The orthodontic treatment planning consisted of alignment and leveling the arches and subsequent retraction, with anchorage on intra-alveolar orthodontic miniscrews, which were positioned between the first molars and second premolars, with the objective of reducing the protrusion and inclination of incisors and consequently improving facial and smile esthetics.

Interactive self-ligating brackets, 0.022-in slot, with MBT prescription were used. This prescription was selected due to the greater torque in upper incisors (central incisors + 17° and lateral incisors + 10°) to obtain greater torque control during retraction, since the upper incisors needed small reduction in their inclination. In the lower arch, torques are reduced (lower incisors -6°), with less torque control, to allow greater reduction of inclination during retraction.

The alignment of the upper and lower arches was initiated with 0.014-in thermoactivated NiTi archwires, followed by 0.018-in; 0.014 x 0.025-in and 0.018 x 0.025-in (Fig 7).

The retraction of both arches began with the 0.019 x 0.025-in stainless steel archwires, anchored in orthodontic miniscrews positioned between the second premolars and first molars, on the buccal side. The ideal initial force for total retraction of the arch is 250g/cm^2 and it should gradually be increased in the following consultations, up to a maximum of 400g[33,34]. This calibration was performed by reducing the spring length. On the upper right side, a milder force was used due to absence of the first molar, offering less resistance to distalization in this hemiarch. The miniscrews used (SIN, Sistema de Implante Nacional S.A., São Paulo/SP) had 1.6-mm diameter, 8.0-mm body length and 1.0-mm transmucosal profile. They were placed at 8.0 mm towards the apex in relation to the main archwire in the upper arch, and at 7.0 mm in the lower arch. This positioning was performed according to the band of keratinized mucosa, which is narrower in the mandible than in the maxilla. The miniscrews were inserted in the mucogingival line (which separates the keratinized from the alveolar mucosa). They were placed with an inclination of 80 to 90° in relation to the cortical plate in the maxilla and more inclined in the mandible (Fig 8).

After six months of retraction, a mild reduction in the inclination of incisor crowns was clinically observed, with consequent reduction in inclination of the lips. This allowed greater interaction by the patient during treatment, who could assess the gradual alteration of the profile and give an opinion on the best time to complete the arches retraction — unlike with premolar extractions, in which total space closure is necessary and often requires changing the anchorage strategy for mesialization of posterior teeth, when the retraction of anterior teeth is no longer desired.

Retraction of the lower arch was performed faster than that of the upper arch, generating an increased overjet. At that moment, the screws in the mandible were removed and the retraction was continued in the upper arch (Fig 9).

After three months of upper retraction, the overjet was normalized, and the canine relationships finalized with an key of occlusion. At that moment, the implant was placed in the region of the upper first molar. After the osseointegration period, the crown was placed on the implant (Fig 10).

Figure 7 - Intermediate thermoactivated NiTi rectangular archwires.

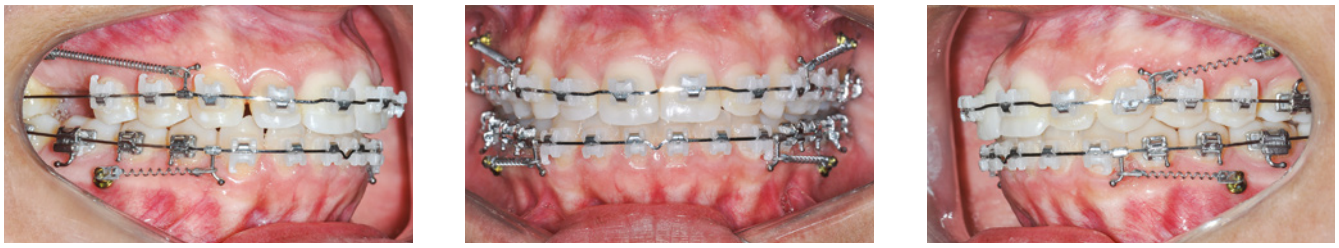

Figure 8 - Initial stage of retraction of the upper and lower arches, with 0.019 x 0.025-in stainless steel archwire, with intra-alveolar miniscrews placed between the second premolars and first molars.

Figure 9 - Intermediate stage of retraction of the upper arch, with 0.019 x 0.025-in stainless steel archwire, and completion of lower retraction.

Figure 10 - Intraoral view of the patient with canines, premolars and molars on the left side in key of occlusion. On the right side, an implant-supported denture was placed with dimensions compatible with an upper third premolar. The incisor relationship was normalized.

Results

Simultaneous retraction of the arches anchored on orthodontic miniscrews was able to retract the upper incisors in 2.3 mm and reduce their inclination by 5° (1.PP=110°). The lower incisors retracted 3.0 mm and reduced their inclination by 10° (IMPA=90°). The upper incisors, despite the retraction and reduction of inclination, maintained their relationship with the FAOP at 2.5 mm. This fact was due to retraction with intrusion vector. The lower incisors were also retracted, with a reduction in inclination; however, they extruded and touched the FAOP (FAOP = +2.5 mm/0.0 mm). Canines, premolars and molars ended in an key of occlusion. The incisor relationship improved, increasing the overjet and overbite (Fig 11).

In the facial aspect, there were small positive changes, with a slight reduction in lip projection, compatible with the small reduction in incisor inclination (Fig 12).

Analysis of the final panoramic radiograph did not show any significant alteration in relation to the initial radiograph, except for implant placement in the region of the upper right first molar (Fig 13).

Cephalometrically, the most relevant changes were reduction of bimaxillary protrusion and inclination of the upper and lower incisors; distalization of all posterior teeth; maintenance of vertical dimension; and improvement of soft tissue esthetics. There was a 16° reduction in the interincisal angle, changing from 111° to 127° (Fig 14).

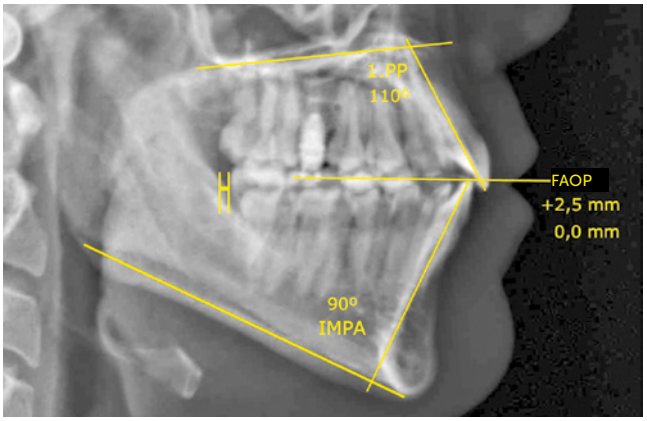

Figure 11 - Final cephalometric measurements.

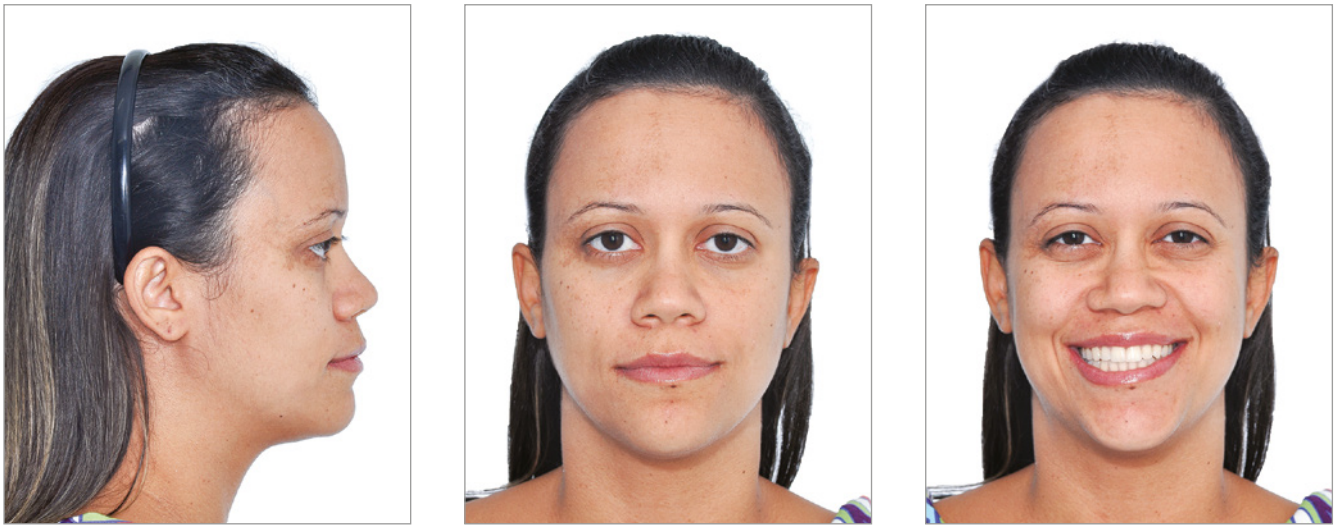

Figure 12 - Final extraoral views.

Figure 13 - Final panoramic radiograph.

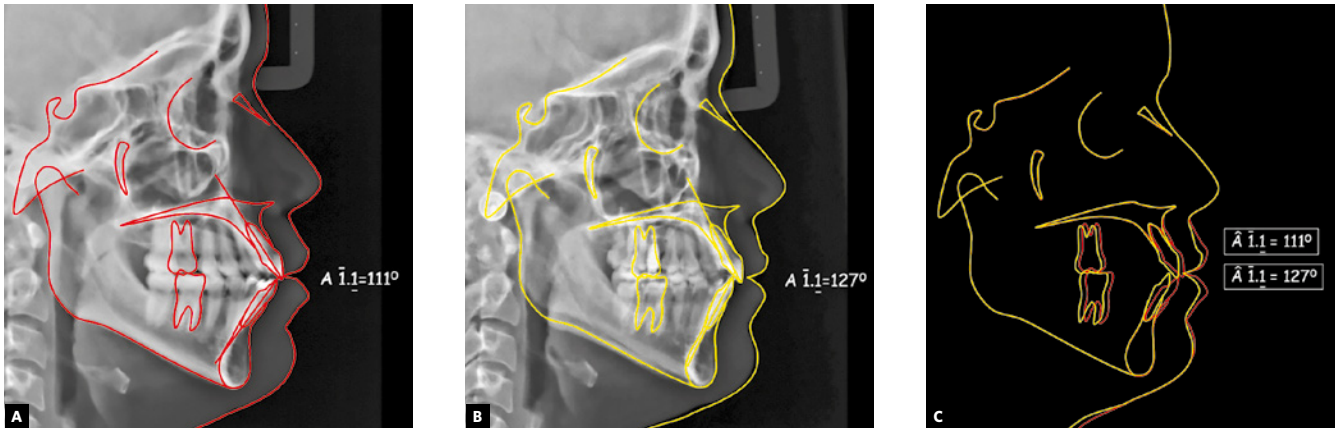

Figure 14 - Initial (A), final (B) and superimposition (C) lateral cephalograms.

CASE REPORT 2

Description and diagnosis

Female patient, aged 27 years, reported dissatisfaction with protruding teeth and lack of passive lip sealing. The frontal facial analysis revealed symmetry, a good proportion between facial height and width and balanced facial thirds, characteristic of mesofacial individuals. The lateral analysis revealed a Pattern I face with good convexity and well-positioned maxilla and mandible. Lateral evaluation of the lower facial third did not reveal increased projection of the upper lip, but interposition of the upper incisors between the lips. This projection of incisors impaired passive lip sealing and promoted lower lip eversion, which compromised the facial esthetics.

In the evaluation of smile, the upper arch presented good vertical exposure of upper incisors and some gingiva. It also revealed increased exposure of incisors with the lips at rest (Figs 15A, 15B and 15C). In a closer view, it was possible to observe the interference of upper incisors on the lips, with increased inclination, both at rest and when smiling, compromising the esthetics (Figs 15D and 15E).

Analysis of the dental arches revealed an Angle Class I malocclusion, with excellent sagittal relationships of molars, premolars and canines, coincident upper and lower dental midlines, mild crowding in the lower arch and decreased overjet and overbite, due to the increased inclination of upper and lower incisors (Fig 16).

The panoramic radiographic analysis showed the absence of lower third molars and the presence of upper third molars. The upper left third molar was mesially angulated and impacted on the second molar. Then, extractions of the upper third molars were requested. The other teeth and periodontal structures had normal conditions (Fig 17).

The initial cephalometric analysis revealed a slight maxillary deficiency and good mandibular positioning; slightly divergent angles of the palatal, occlusal and mandibular planes; and normal height of the lower facial third, characteristic of mesofacial individuals (Fig 18).

» Upper incisors had increased inclination (1.PP=124°).

» Upper incisors had a slightly increased vertical relationship with the upper lip, namely 4.5 mm; however, the lower incisors required extrusion of 2.0 mm to touch the FAOP plane (FAOP=4.5 mm/-2.0 mm).

» Lower incisors had increased inclination (IMPA=105°).

» Presence of reduced space in the retromolar region (RMR), yet sufficient to distalize the lower arch (Fig 19).

Figure 15 - **A-C**) Initial extraoral views. **D, E**) Close views of the lips, at rest and smiling.

Figure 16 - Initial intraoral views of the patient with Class I malocclusion, bimaxillary protrusion and reduced overjet and overbite.

Figure 17 - Initial panoramic radiograph.

Figure 18 - Initial lateral cephalogram.

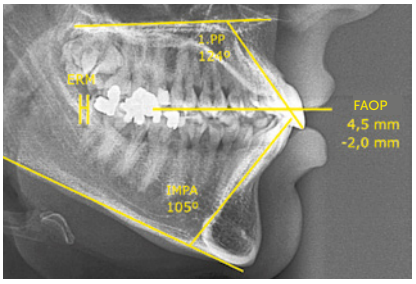

Figure 19 - Initial cephalometric measurements.

Treatment planning and mechanics employed

The orthodontic treatment planning consisted of alignment and leveling, with subsequent retraction of the arches, anchored on extra-alveolar orthodontic miniscrews, which were positioned between the first and second molars, to reduce the protrusion and inclination of incisors, with consequent improvement of facial function and esthetics.

Passive self-ligating brackets (Easy Clip Plus, Aditek do Brasil Ltda), with 0.022-in slot, standard Damon prescription were used. This prescription was chosen for the upper and lower incisors and canines. In the upper arch, the values were: central incisors +15°, lateral incisors +6° and canines +7°. The upper teeth required a small reduction in their inclination, with little control during retraction. It should be remembered that the working archwire used for retraction is 0.019 x 0.025-in stainless steel, and that there is a gap of nearly 12° between the arch and bracket slot.[32] If greater torque control was necessary, without the need to reduce the inclination, the prescription of choice would be high torque (central incisors +22°, lateral incisors +13° and canines +11°). In the lower arch, the torques in the incisors are more reduced (incisors -3° and canines +7°); the prescription of +7° in the canines prevents exaggerated lingual inclination of these teeth during retraction, helping in the transverse control.

The alignment of upper and lower arches was started, with 0.014-in thermoactivated NiTi archwires; followed by 0.018-in and 0.014 x 0.025-in (Fig 20).

In the 0.018 x 0.025-in archwire, after complete alignment and leveling of the arches, interproximal stripping was performed on the upper and lower incisors, to improve the anatomy of crowns, which had triangular shape and dark spaces in the papilla spaces, known as black spaces (Fig 21).

The retraction of both arches started with the 0.019 x 0.025-in stainless steel archwires anchored on extra-alveolar orthodontic miniscrews. In the maxilla, the screws were positioned in the region of the infrazygomatic crest (IZC), in the mesial aspect of upper second molars, on the buccal side. In the mandible, the screws were placed between the second molars and first molars on the buccal side, in the region known as buccal shelf. These two sites have a greater amount of cortical bone and the screws are inserted as vertically as possible. This strategy aims at positioning the body as far from the roots as possible to allow greater sagittal corrections. The initial force used was 250 g/cm^2, increased in the following consultations, by reducing spring length. Stainless steel screws (Bioray, New Taipei City, Taiwan), with 2.0-mm diameter, 2.0-mm transmucosal profile and 10.0-mm body length were placed (Fig 22).

After eight months of retraction, a reduction in incisor inclination was clinically observed, with consequent improvement in overjet and overbite. The lips then showed passive lip sealing (Fig 23).

Figure 20 - Initial 0.014-in thermoactivated NiTi archwires.

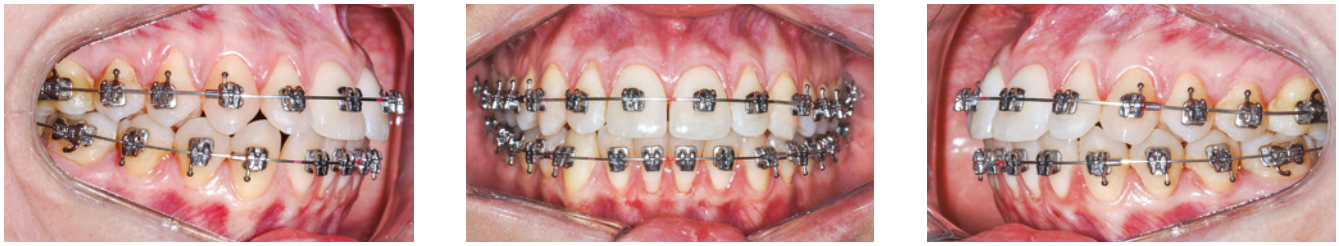

Figure 21 - 0.018 x 0.025-in rectangular intermediate thermoactivated NiTi archwires.

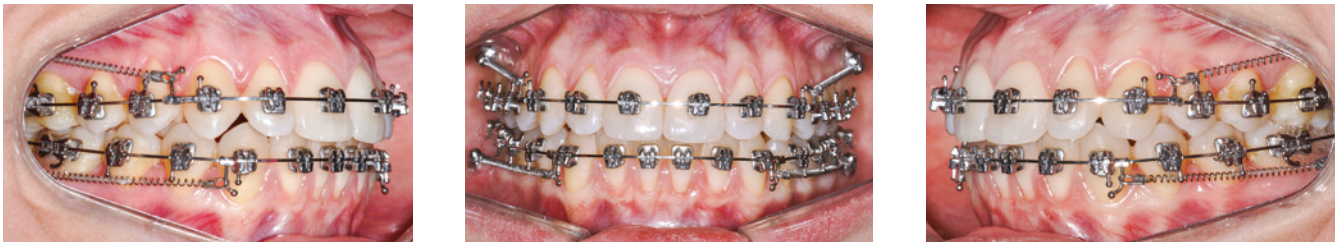

Figure 22 - Initial stage of retraction of the upper and lower arches, with 0.019 x 0.025-in stainless steel archwire, with extra-alveolar miniscrews placed between the first and second molars.

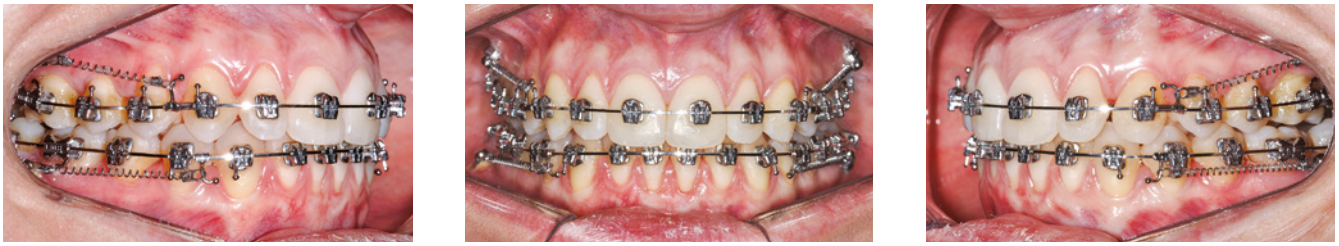

Figure 23 - Final stage of retraction of upper and lower arches, with 0.019 x 0.025-in stainless steel archwire.

Results

At treatment completion, the upper incisors were retracted with vertical control, without extrusion. The lower incisors reduced the inclination and extruded. Canines, premolars and molars ended in key of occlusion (Fig 24).

Simultaneous traction of the arches with anchorage on extra-alveolar screws allowed retraction of upper incisors in 5.0 mm and reduced their inclination by 12° (1.PP=112°). The lower incisors retracted 5.5 mm and reduced their inclination by 14° (IMPA=91°). The relationship between incisors improved, increasing the overjet and overbite. The upper incisors, despite the retraction and reduction of inclination, improved their relationship with the FAOP, going to 3.5 mm. This was due to retraction with an intrusion vector. The lower incisors were also retracted with reduced inclination; however, they extruded and touched the FAOP (FAOP=3.5 mm/0.0 mm) (Fig 25).

In the facial aspect, there were positive changes, with reduced incisor inclination, which allowed passive lip sealing and a more harmonious smile. However, retraction of the upper incisors reduced the exposure of the upper lip vermillion, which is not a positive aspect (Fig 26).

Analysis of the final panoramic radiograph showed good parallelism of the roots and without the upper third molars. The other periodontal structures maintained normal conditions (Fig 27).

Cephalometrically, the most relevant changes were reduction of bimaxillary protrusion and inclination of the upper and lower incisors, distalization of all posterior teeth, maintenance of vertical dimension and improvement of soft tissue esthetics. There was a 27° reduction in the interincisal angle, changing from 105° to 132° (Fig 28).

Figure 24 - Intraoral views of the patient with canines, premolars and molars in key of occlusion and normal relationship of incisors.

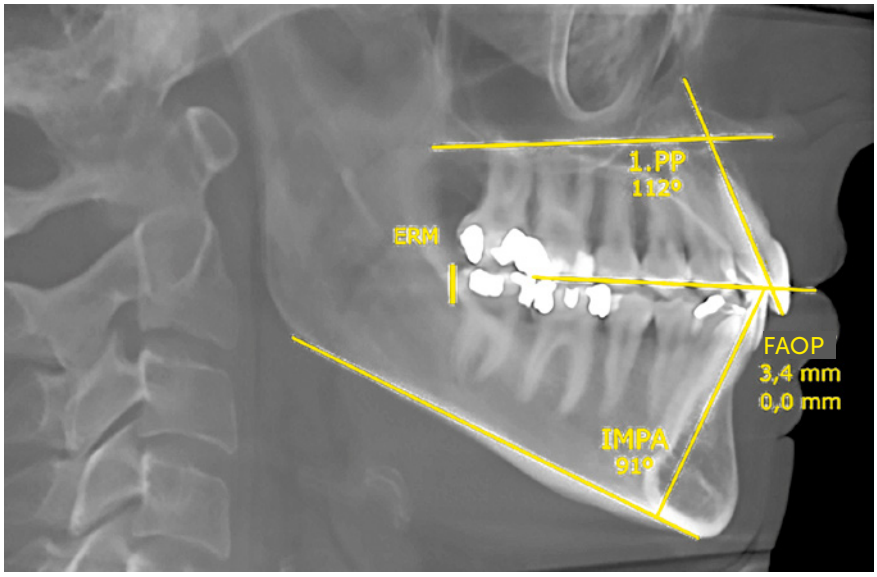

Figure 25 - Final cephalometric measurements.

Figure 26 - Final extraoral views.

Figure 27 - Final panoramic radiograph.

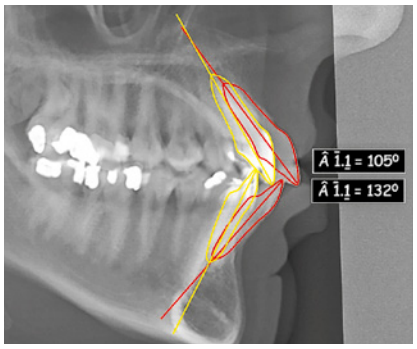

Figure 28 - Superimposition of the tooth movement performed and comparison of the change in the interincisal angle.

CASE REPORT 3

Description and diagnosis

A 36-year-old female patient reported great dissatisfaction with the protrusion of teeth and lack of passive lip sealing. The frontal facial analysis showed symmetry, balanced facial thirds and a good proportion between facial height and width, characteristic of mesofacial individuals. The lateral analysis revealed a Pattern I face, with good convexity, well-positioned maxilla and mandible. Lateral evaluation of the lower facial third revealed exaggerated projection of the upper and lower lips, with interposition of upper incisors between them. This increased incisor inclination prevented passive lip sealing and compromised the facial esthetics.

When evaluating the smile, the upper arch presented good vertical exposure of the upper incisors and some gingiva. Despite this good vertical relationship, the smile was unpleasant, due to the exaggerated inclination of incisors. There was also increased exposure of incisors with the lips at rest (Fig 29).

The analysis of dental arches revealed Angle Class I malocclusion, with excellent sagittal relationships of molars, premolars and canines, coincident upper and lower dental midlines, aligned dental arches, without crowding, and decreased overbite and overjet, due to the increased inclination of upper and lower incisors (Fig 30).

The analysis of panoramic radiograph showed absence of upper and lower third molars. The other teeth and periodontal structures had normal conditions (Fig 31).

The initial cephalometric analysis revealed good positioning of the maxilla and mandible; slightly divergent angles of the palatal, occlusal and mandibular planes; and normal height of the lower facial third, characteristic of mesofacial individuals (Fig 32).

» Upper incisors presented increased inclination (1.PP=128°).

» Upper incisors had a slightly increased vertical relationship with the upper lip, of 5.0 mm; however, the lower incisors needed to extrude 3.0 mm to touch the FAOP plane (FAOP=+5.0 mm/-3.0 mm).

» Lower incisors presented increased inclination (IMPA=117°).

» Presence of good space in the retromolar region (RMR), sufficient to distalize the lower arch (Fig 33).

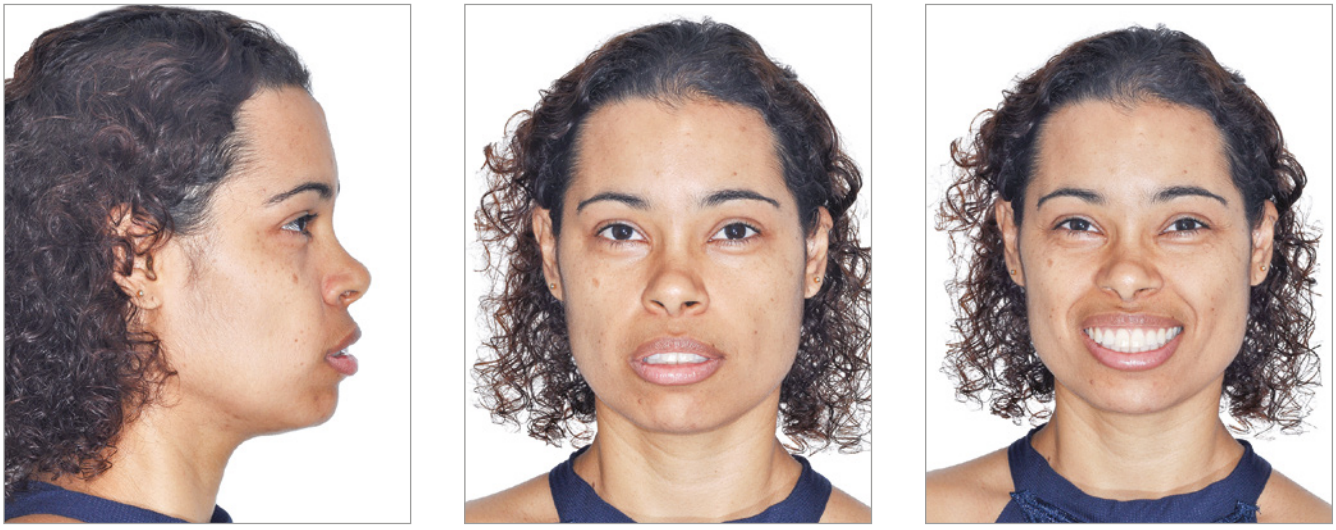

Figure 29 - Initial extraoral views.

Figure 30 - Initial intraoral views of the patient with Class I malocclusion, bimaxillary protrusion and reduced overjet and overbite.

Figure 31 - Initial panoramic radiograph.

Figure 32 - Initial lateral cephalogram.

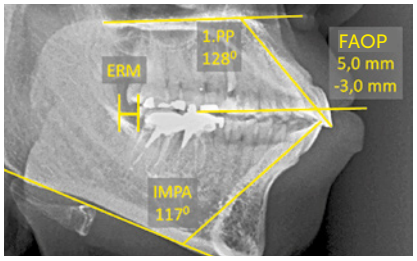

Figure 33 - Initial cephalometric measurements.

Treatment planning and mechanics employed

The orthodontic treatment planning consisted of alignment and leveling with subsequent retraction of the arches, with anchorage on extra-alveolar orthodontic miniscrews. These screws were positioned between the first and second molars to reduce the protrusion and inclination of incisors and consequently improve the function and facial esthetics.

Passive self-ligating brackets Easy Clip Plus (Aditek do Brasil Ltda., Cravinhos/SP, Brazil) were used, with 0.022-in slots, standard Damon prescription. This prescription was chosen for the upper and lower incisors and canines. The upper teeth required great reduction in inclination. It was planned to achieve this reduction by retraction, rather than by reduced torque.

The alignment of upper and lower arches was initiated with 0.014-in thermoactivated NiTi archwires, followed by 0.014 x 0.025-in and 0.018 x 0.025-in archwires (Fig 34).

Retraction of the two dental arches began with 0.019 x 0.025-in stainless steel archwires anchored on extra-alveolar orthodontic miniscrews, which were positioned on the infrazygomatic crest (IZC) and on the buccal shelf. The initial force used for total retraction of the arches was 250g/cm^2, gradually increased in the following consultations, by reducing the spring length. After 8 months of retraction, the springs were replaced by medium elastomeric chains, to generate more retraction force, used for another 6 months, adding up to 14 months of retraction. The extra-alveolar miniscrews placed were made of stainless steel, (DAT Steel, São Bernardo do Campo/SP, Brazil), with 2.0-mm diameter, 2.0-mm transmucosal profile and 10.0-mm body length (Fig 35).

After 14 months of retraction, a reduction in incisor inclination was clinically observed, with consequent improvement in overjet and overbite. The lips started to show passive sealing (Fig 36).

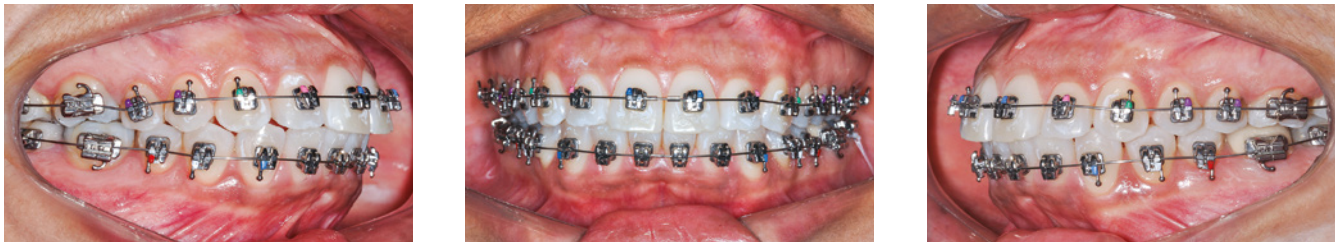

Figure 34 - Initial 0.014-in initial thermoactivated NiTi archwires.

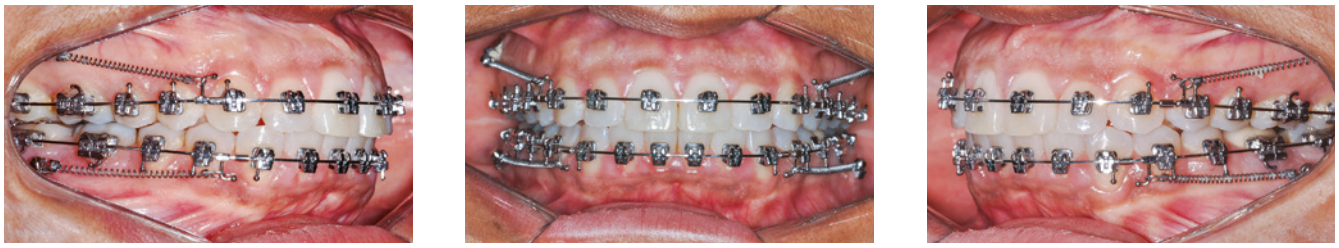

Figure 35 - Initial stage of retraction of upper and lower arches, with 0.019 x 0.025-in stainless steel archwire, with extra-alveolar miniscrews placed between the first and second molars.

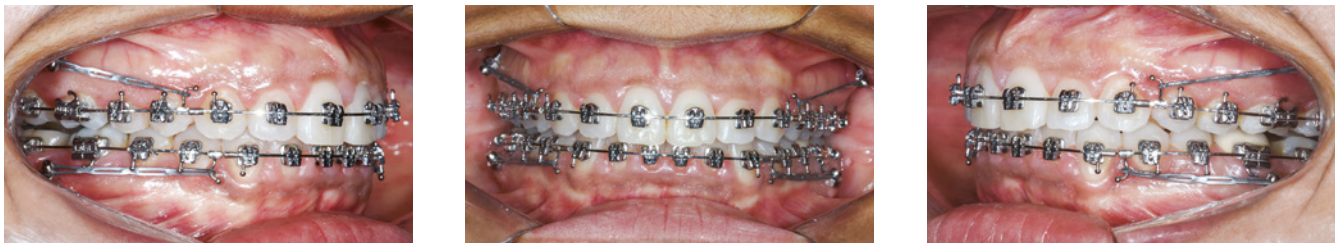

Figure 36 - Final stage of retraction of the upper and lower arches, with 0.019 x 0.025-in stainless steel archwire.

Results

At treatment completion, the upper incisors retracted, with slight intrusion, due to vertical control. The lower incisors reduced the inclination and extruded, normalizing the overjet and overbite. Canines, premolars and molars ended in key of occlusion (Fig 37).

Simultaneous traction of the arches with anchorage on the extra-alveolar screws managed to retract the upper incisors in 7.0 mm and reduced their inclination by 16° (1.PP=112°). The lower incisors retracted 8.5 mm and reduced their inclination by 26° (IMPA=91°). The upper incisors, despite the retraction and reduction of inclination, improved their relationship with the FAOP, changing to 3.5 mm. This was due to retraction with an intrusion vector. The lower incisors were also retracted, with reduction in their inclination; however, they extruded and touched the FAOP (FAOP +3.5 mm/0.0 mm) (Fig 38).

In the facial aspect, there were positive changes, with reduced incisor inclination, which allowed passive lip sealing and a more harmonious smile. Despite the great retraction, the lips continued with increased volume, due to their greater thickness (Fig 39).

Analysis of the final panoramic radiograph showed good parallelism of the roots. The other periodontal structures maintained normal conditions (Fig 40).

Cephalometrically, the most relevant changes were reduction of bimaxillary protrusion and inclination of the upper and lower incisors, distalization of all posterior teeth, maintenance of vertical dimension, and improvement of soft tissue esthetics. There was a reduction of 39° in the interincisal angle, from 92° to 131° (Fig 41).

Figure 37 - Intraoral views of the patient with canines, premolars and molars in key of occlusion, and normal relationship of incisors.

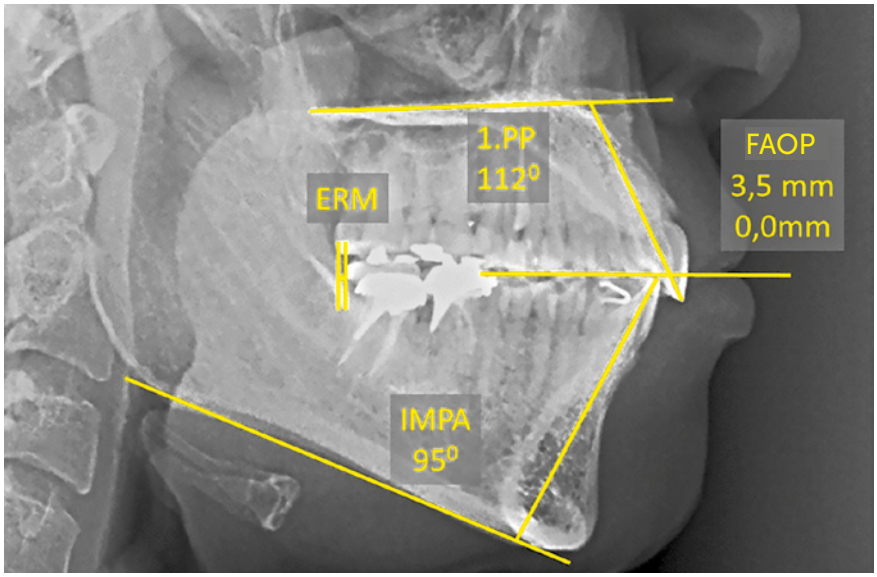

Figure 38 - Final cephalometric measurements.

Figure 39 - Final extraoral views.

Figure 40 - Final panoramic radiograph.

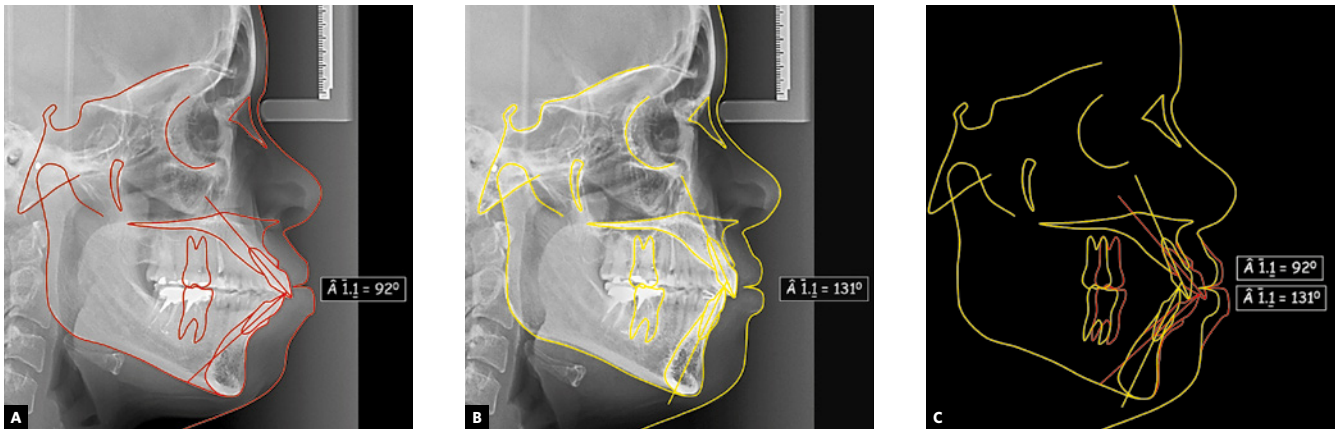

Figure 41 - Initial (**A**), final (**B**) and superimposition (**C**) of lateral cephalograms, illustrating the change that occurred in the interincisal angle.

DISCUSSION

The facial esthetic results resulting from anterior retractions varied according to the amount of retraction of incisors and lip thickness. According to the study of Hayashida et al.[3], the results are influenced by the ethnic background.

Total retraction of the arches without extractions using skeletal anchorage was able to achieve great movements and may be more efficient than conventional mechanics, with extraction of first premolars. This strategy provided retractions of up to 8.5 mm of the lower incisors, as shown in Case 3. Willians and Hosila[35] concluded that, in cases involving extraction of the first four premolars, approximately 66.5% of the available extraction space was occupied by retraction of the anterior segment. In the present clinical cases, we decided to perform retraction of both arches, with the aid of orthodontic screws associated with self-ligating appliances, instead of extracting four premolars. This is an excellent treatment option, since it does not reduce the volume of first premolars in the arches, maintaining the transverse volume of smile. According to Ong and Woods,[36] the general average reduction of the arch perimeter was 11.3 mm with extractions of premolars. However, previous studies[37,38] have shown that, in cases of association of crowding with dental protrusions, these extractions should be indicated.

The association of intra- and extra-alveolar screws with self-ligating brackets and thermoactivated archwires reduces the number of consultations, since the archwires can be changed every two months. This fact does not compromise the efficiency nor increases the overall treatment time.[14,15,18,39]

The variable prescriptions in these cases of bimaxillary protrusion, in which the median or standard torque was used, do not present great advantages over other prescriptions, since a great control of incisor torque was not required because the side effect of incisor retroclination during retraction of the arches was desired. Only the torques of upper and lower canines should be 7° positive, to inhibit the tendency of lingual inclination of these teeth during retraction.

The intra-alveolar miniscrews can be used as anchorage in the treatment of cases with mild bimaxillary protrusion, due to the limited space between the roots. However, it is possible to increase the amount of retraction by changing the screw position, to continue distalization and achieve greater movements.[26]

The extra-alveolar miniscrews proved to be an excellent anchorage option in the treatment of moderate to severe bimaxillary protrusion, avoiding the extraction of premolars. The magnitude of retraction occurred according to the time of use of the mechanics, since the body of screws was not an obstacle for root movement. Total retraction of the arches in the correction of severe bimaxillary protrusion lasted 14 months, while in moderate bimaxillary protrusion it lasted 8 months. The retraction of upper incisors required an intrusion component to maintain a good vertical relationship with the lips. The lower incisors were extruded to improve the overbite. The understanding and skill of biomechanics in the use of skeletal anchorage is necessary to achieve more predictable and desirable results.

The disadvantage of this type of approach is the need to use skeletal anchorage devices, which requires specific knowledge of the professional, both for placement and control of biomechanics. In addition, the use of miniscrews can raise resistance in patients, since it is an invasive procedure.

This approach reduces the indication of extraction of first premolars; however, it requires space distal to the second molars to achieve the total retraction of the arches. This leads to a frequent request for extraction of third molars, which is better accepted by patients, since it does not compromise the esthetics and their removal is usually indicated.

Thermoactivated NiTi archwires have important characteristics in the initial treatment stage, as they respond differently when subjected to low or high tension. These archwires, when submitted to small deflections, present an excellent elastic recovery; however, when they are subjected to large deflections, resulting from irregular positioning of the teeth, they become more flexible, dissipating a milder force. As the teeth move and the irregularities decrease, the tension decreases and the elastic recovery capacity increases, becoming a little less flexible. This property allows maintenance of this type of archwire for a longer time in the initial treatment stages, since they release more constant forces during the process of correcting tooth irregularities. This reduces the need for monthly archwire changes and the number of different archwire sizes. When associated with self-ligating brackets, which do not require the monthly replacement of elastic ligatures, they allow patients to stay longer with the mechanics installed and reduce the number of consultations.

CONCLUSION

The self-ligating brackets system associated with skeletal anchorage with intra- and extra-alveolar miniscrews proved to be efficient in correcting mild, moderate and severe bimaxillary protrusion, with improved lip posture, without reducing the volume of the first premolars in the arches and consequently maintaining the transverse volume of the smile. This strategy can bring some advantages, such as: decreased indication of premolar extractions; reduced need of patient compliance; simplification of orthodontic mechanics; and simplified placement and removal of screws. Self-ligating appliances, together with high-tech thermoactivated archwires used in the initial treatment stages, can reduce the number of consultations, which can be more spaced, without compromising the results or increasing the overall treatment time.

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Abstract

— The abstract should be structured following a one or two sentences description of a brief introduction and aim of the manuscript, treatment objectives, results and conclusion.

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— This section should be brief. The author must introduce the reader to the problem that is illustrated by the case report. This section should consist of one to three paragraphs, and it should begin with a general description of the problem to be illustrated, have a brief description of the literature and should end with a sentence that leads the reader into the purpose of the report.

Diagnosis and etiology

— The author should describe the dental and skeletal diagnosis. It is important to focus on the uniqueness or abnormality of the case and not on the normal findings. Anamnesis information, etiology of the malloclusion and any other information that would interfere with the treatment plan should be described. Preteatment radiographs and complete records are needed (models should be used if the intraoral radiographs can't portrait the clinical case and authors may be asked to submit pictures of the dental casts at the discretion of the editor). The author should refer to specific cephalometric measurements if necessary, and refer the reader to radiographs and photographs.

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— The author must refer to all possible and reasonable treatment plans and describe the advantages and disadvantages of each alternative. The alternative chosen should be also described.

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— The author must describe the treatment for the patient thoroughly. Types of appliances, prescription, length of treatment, interaction with other aspects of dentistry, and special decisions that were made during treatment should be included.

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— In this section the author should describe the results of orthodontic treatment. Final records must be presented in the same manner initial records were presented. In growing patients, total and partial superimposition are needed (Björk's method is suggested), while only a total superimposition for non-growing patients. It is important that the objectives and aim of the clinical case presentation are supported by the results. Conventional cephalometric measurements should be used, along with any specific measurement as long as they pertain to the objective of the clinical cases. It is suggested that the cephalometrics taken per each phase should not exceed 15 measurements

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Summary and conclusions

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1. Registration of clinical trials

Clinical trials are among the best evidence for clinical decision making. To be considered a clinical trial a research project must involve patients and be prospective. Such patients must be subjected to clinical or drug intervention with the purpose of comparing cause and effect between the groups under study and, potentially, the intervention should somehow exert an impact on the health of those involved.

According to the World Health Organization (WHO), clinical trials and randomized controlled clinical trials should be reported and registered in advance.

Registration of these trials has been proposed in order to (a) identify all clinical trials underway and their results, since not all are published in scientific journals; (b) preserve the health of individuals who join the study as patients and (c) boost communication and cooperation between research institutions and other stakeholders from society at large interested in a particular subject. Additionally, registration helps to expose the gaps in existing knowledge in different areas as well as disclose the trends and experts in a given field of study.

In acknowledging the importance of these initiatives and so that Latin American and Caribbean journals may comply with international recommendations and standards, BIREME recommends that the editors of scientific health journals indexed in the Scientific Electronic Library Online (SciELO) and LILACS (Latin American and Caribbean Center on Health Sciences) make public these requirements and their context. Similarly to MEDLINE, specific fields have been included in LILACS and SciELO for clinical trial registration numbers of articles published in health journals.

At the same time, the International Committee of Medical Journal Editors (ICMJE) has suggested that editors of scientific journals require authors to produce a registration number at the time of paper submission. Registration of clinical trials can be performed in one of the Clinical Trial Registers validated by WHO and ICMJE whose addresses are available at the ICMJE website. To be validated, the Clinical Trial Registers must follow a set of criteria established by WHO.

2. Portal for promoting and registering clinical trials

With the purpose of providing greater visibility to validated Clinical Trial Registers, WHO launched its Clinical Trial Search Portal (http://www.who.int/ictrp/network/en/index.html), an interface that allows simultaneous searches in a number of databases. Searches on this portal can be carried out by entering words, clinical trial titles or identification number. The results show all existing clinical trials at different stages of implementation with links to their full description in the respective Primary Clinical Trials Register.

The quality of 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 the 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, 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.

Currently, the Network of Collaborating Registers is organized in three categories:

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DENTAL PRESS JOURNAL OF ORTHODONTICS endorses the policies for clinical trial registration enforced by the World Health Organization - WHO (http://www.who.int/ictrp/en/) and the International Committee of Medical Journal Editors - ICMJE (# http://www.wame.org/wamestmt.htm#trialreg and http://www.icmje.org/clin_trialup.htm), recognizing the importance of these initiatives for the registration and international dissemination of information on international clinical trials on an open access basis. Thus, following the guidelines laid down by BIREME / PAHO / WHO for indexing journals in LILACS and SciELO, DENTAL PRESS JOURNAL OF ORTHODONTICS will only accept for publication articles on clinical research that have received an identification number from one of the Clinical Trial Registers, validated according to the criteria established by WHO and ICMJE, whose addresses are available at the ICMJE website http://www.icmje.org/about-icmje/faqs/clinical-trials-registration/. The identification number must be informed at the end of the abstract.

Consequently, authors are hereby recommended to register their clinical trials prior to trial implementation.

Yours sincerely,

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Factors associated to quality of life of orthodontists graduated from a public university (1993-2016): A mixed-methods approach

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Introduction: For dental professionals, including orthodontists, Quality of life (QOL) is a topic of growing concern and could be determined by objective and subjective complex factors.

Objective: This study analyzed the factors that influence the QOL of orthodontists graduated between 1993 and 2016 of a public university (Medellín, Colombia).

Methods: A mixed-methods study was conducted (cross-sectional survey; 88 participants; 3 focus groups, 21 participants). Quantitative analysis: the research included sociodemographic, labor and health characteristics as independent variables and the WHOQOL-BREF questionnaire as main outcome for QOL. Frequencies were calculated and the association between QOL and independent variables was estimated by bivariate analysis (Chi square tests) and a linear multivariate regression. Qualitative analysis: Narrative content analysis according to thematic categories. Mixed methods: a conceptual framework for QOL using the triangulation was developed.

Results: All the scores surpassed 55 points on the 4 domains of WHOQOL-BREF. A lower value was found in the physical dimension (57.1±10.7) and a greater value in the psychological dimension (70.8±8.3). The variables associated positively to QOL were permanent contract, teaching/research activities, monthly income, resting days per week and sex. Factors associated negatively were low social support, mental health and rent housing. Discourses of participants allowed to identify the concept of QOL and the contextual and social determinants and satisfiers.

Conclusion: QOL of orthodontists is influenced by sociodemographic, employment, working and health factors. Therefore, QOL is a multidimensional concept that recognizes the political and socio-economic context and personal and professional experiences.

Keywords: Quality of life. Orthodontists. Health surveys. Dental research. Qualitative research.

[1] Universidad de Antioquia, Facultad de Odontología (Medellín, Colombia).

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INTRODUCTION

Quality of life (QOL) is a broad concept that is affected by objective and subjective factors such as physical health, psychological status, level of independence, social support, personal beliefs and the environment.[1,2] The multidimensional connotation of QOL has been studied in diverse population groups and is recognized as a dynamic process, because of the factors that can influence over the time.[2-5] According to the United Nations Development Programme (UNDP) and its Human Development Report (2018), Colombia has a high Human Development Index of 0.777 (on a scale of 0 to 1), ranking 90th worldwide.[6] Specifically in Medellin (the second largest city in the country), the municipal government carried out the multidimensional index of living conditions, and the perception of QOL in the region is 0.653 (values close to 1 indicate a better situation).[7]

For dental professionals, QOL is currently a topic of growing concern.[8-10] Dentists at working place are under a constant pressure that demands skills, physical energy and concentration. They are exposed to a number of occupational diseases, and they are vulnerable to multiple hazards: ergonomic, physical, chemical, biological, and psychosocial.[10,11] In addition, they have a lot of necessities for education and training in order to offer update knowledge and technology to keep up with patients' increasing demand. [8-10]

The neoliberal economic model adopted in the country has brought changes in the practice of autonomous health professionals, including general dentistry and its specialties (such as orthodontics).[8,12] Therefore, an oversupply of general dentists and specialists is observed in some regions of the country, and this situation impacts in the precarious working conditions, having multiple jobs, long working days, and inter-municipal transfers for working in different dental offices.[8,12] In addition, the city of Medellín (and its metropolitan area) has four dentistry schools (three of them are private) and three universities have orthodontics specialization programs (one of them is public). These aspects can affect the QOL of professionals and consequently the ability to provide high quality dental care.[8]

International research about the QOL in dentists have been found, but not in a broad way. For instance, one study conducted in Brazil[5] identified a low QOL related to physical and psychological health. Other studies conducted in India[9] and United Arab Emirates[10] analyzed the sociodemographic and labor characteristics that influence QOL in different settings. No empirical studies have been identified in Colombia that measured QOL in dentists, but studies related to the work profile, living conditions, work-life balance and job satisfaction in these professionals are found.[12-14] For that purpose, new methodological approaches are requested to address broadly the social determinants affecting QOL in orthodontists. In this case, mixed methods are increasingly being used in research studies on multifunctional oral health issues.[15] The knowledge of the social reality of these professionals permits generating strategies and political actions to improve health.

Accordingly, this study aims to analyze the factors that influence the QOL of the orthodontists graduated between 1993 and 2016 from a public university (Colombia).

METHODS

Ethics

Participation in the study was voluntary. All respondents gave written informed consent to participate in the study, and confidentiality was guaranteed throughout the research process in accordance with Colombian regulations (Resolution no. 008430/1993-Ministry of Health and Social Protection). The Ethical Committee of the Faculty of Dentistry at University of Antioquia approved the study (07-2017).

Design

A mixed-methods study was conducted by means of a sequential explanatory design,[15] which means that qualitative tools were used to explain what was observed in the first quantitative phase. Fieldwork was carried out between June 2017 and July 2018. All the components are referenced below.

Quantitative sub-study

A cross-sectional survey was applied for orthodontists graduated from the Faculty of Dentistry of the University of Antioquia (Medellín, Colombia). Data were provided by the *Asociación de Ortodoncistas de la Universidad de Antioquia* (Association of Orthodontists of the University of Antioquia). The final sample was 88 (response rate: 68%), considering a voluntary participation.

For the correct filling of the surveys, the research team attended several meetings scheduled by the Association. The questionnaire was self-administered, but advice was given if needed and were later delivered to the researchers during all the events (questionnaire available upon request). All surveys were anonymous and confidential. A pilot study was carried out in a sample of 10 dentists in order to improve intelligibility and to assess time to completion and internal consistency.

The main outcome was the Health-Related Quality of Life (HRQOL), as measured by the WHOQOL-BREF.[16,17] This is a generic questionnaire to measure QOL, created by the Study Group on Quality of Life of the WHO, and comprises 26 items distributed on four broad domains: physical health, psychological health, social relationships, and environment. Domain scores are scaled in a positive direction from 1 to 5 (i.e., higher scores denote higher quality of life). All the items give a raw score, which is transformed to a 0-100 scale, according to the recommendations of the Study Group. This questionnaire has been validated and is available in 19 languages, including Spanish.[16,17]

Explanatory variables were included: employment conditions, socio-demographics, mental health (measured with the 12-item version of the General Health Questionnaire GHQ-12, responses were rated and summed, and individuals with a score of 3 or higher were classified as having poor mental health).[18] The Duke-UNC-11 questionnaire was used to measure social support. This instrument containing 11 items evaluates perceived functional or qualitative social support. Each item is scored on a frequency rating from 1 (*"Much less than I would like"*) to 5 (*"As much as I would like"*). The score was calculated by adding up the responses to each item, with a higher score denoting greater social support. The cut-off point for low levels of social support is the 15th percentile, corresponding to a score of 32.[19]

A descriptive analysis was carried out for all variables. The Kolmogorov-Smirnov test was used for verifying normality distribution in the main outcome. A bivariate analysis was conducted for the scores of the domains of HRQOL with qualitative explanatory variables, and tests of statistical significance were carried out to observe differences among variables, according to their nature (Mann-Whitney U test, for dichotomous variables; Kruskal-Wallis test, for polychotomous variables; and the Spearman correlation, for quantitative variables). A linear multivariate regression analysis was carried out in order to evaluate the simultaneous and reciprocal effect of the explanatory variables on each of the dimensions of WHOQOL-BREF and to identify possible predictors of their scores. Belonging was determined by evaluating the compliance with the assumptions of linearity, non-collinearity and normality, constant variance and correlation of residuals. All analyses used a level of statistical significance of <0.05. SPSS software version 22.0 (IBM®) was used to carry out all of the analyses.

Qualitative sub-study

A qualitative approach (focused ethnographic perspective) was conducted by means of three focus group discussions (FGD) and participated 21 orthodontists that previously completed the survey (selected for convenience). The research team produced a guide for use in the FGDs that indicated a series of topics to be discussed among participants (according to quantitative survey).The FGD were conducted by two members of the research team. FGDs lasted between 60 and 90 min, and were digitally recorded and transcribed literally. FGDs were performed until data saturation was reached, meaning that no new information emerged.

Narrative content analysis was conducted, identifying significant pieces of text and trends of information found in the participants' discourse. Data analysis were conducted by three of the authors, who examined and compared their analyses. Transcribed data were imported into the qualitative analysis software Atlas. Ti 8.0 and the final analysis was supervised by one of the research team. The text fragments were labeled in 126 codes and then grouped into three categories.

The methods integration approach

The integration of both sub-studies was carried out by means of triangulation.[13] A conceptual framework was formulated, identifying the factors influencing QOL in several levels, according to individuals' opinions and social factors related to the particularities of this orthodontists' group in Colombia.

RESULTS

Sociodemographic, labor, health and QOL profile of participants

General profile for the study sample is provided in a supplementary table. Participated 88 orthodontists (52% females), with an average age of 42±7 years. The median scores for QOL according to the WHOQOL-BREF were over 50, with the best score in the psychological dimension (Me= 71; IQR= 8) and the worst score in the physical dimension (Me= 57; IQR= 11). 66% practice sports; 14% perceived poor general health, 23% poor mental health and the social support is considered as low in 6% of cases.

Sociodemographic, labor and health aspects associated with QOL in their dimensions

Table 1 shows the bivariate correlations between the WHOQOL-BREF dimensions of QOL and the quantitative variables in the study sample. A negative statistically significant correlations was found in case of years of graduation as orthodontist and the social dimension (the score of QOL in this dimension is lower in more recent graduated orthodontist). For the environment dimension of QOL, negative statistically significant correlations for the number of family people in charge and working hours per week (the score of QOL in this dimension is lower in those participants with a greater number of people in charge and those having more working hours per week). A positive statistically significant correlations were found for the variable resting hours per week and the environment dimension (the QOL is higher in those participants with more resting days per week).

Table 2 shows the bivariate comparison between the WHOQOL-BREF dimensions of QOL and the qualitative variables in the study. Statistically significant differences in the median scores were found for the physical dimension and the variables: teaching/research and other labors, temporal contracts, mental health. For the psychological dimension, statistically significant differences in the median scores were found in case of the variables: teaching/research labors, temporal contracts, self-rated health and mental health. For social dimension of QOL, statistically significant differences in the median scores were observed for the variables: social support and mental health. Finally, for the environment dimension, statistically significant differences in the median scores were observed according to the variables: sex, housing, social support, self-rated health and mental health.

Potential predictors of QOL

According to the multivariate linear regression models (Table 3), poor mental health was a negative predictor variable in physical, psychological, and environment dimensions (having poor mental health is associated with a low QOL). To have a rent house was a negative predictor in case of physical and environment dimensions. To work in labors related to teaching/research was a positive predictor variable for QOL in the psychological and environment dimensions. Social support (low) was a negative predictor variable for the psychological dimension of QOL. Finally, to have resting days per week, sex (to be a woman) and monthly income were positive predictors for QOL for the environment dimension. The independent variables described

Table 1 - Correlations between the WHOQOL-BREF dimensions of quality of life and the sociodemographic, labor and health variables in the study sample. Medellín, 2018 (n= 88).

Variables	WHOQOL-BREF dimensions			
	Physical	Psychological	Social	Environment
Age	0.2	-0.02	0.1	-0.1
Years of graduation as orthodontist	-0.02	-0.04	-0.3*	-0.14
Number of people in charge (family)	-0.12	-0.1	-0.1	-0.3*
Working hours per week	-0.1	-0.02	-0.04	-0.3*
Resting days per week	0.04	0.06	0.2	0.3**
Number of jobs	-0.13	-0.1	-0.05	-0.14
Body Mass Index	-0.07	-0.12	-0.03	-0.2

Spearman's rank correlation coefficient. * p-value < 0.05 and > a 0.01. ** p-value < 0.01 and > a 0.001*. *** p-value <0.001.

Table 2 - Bivariate comparison of the WHOQOL-BREF dimensions of quality of life and the qualitative variables in the study sample. Medellín, 2018 (n= 88).

Variables	WHOQOL-BREF dimensions											
	Physical			Psychological			Social			Environment		
	Me	IQR	p-value	Me	IQR	p-value	Me	IQR	p-value	Me	IQR	p-value
Sex												
Males	55.4	10.7	0.86	70.8	12.5	0.88	66.7	16.7	0.55	68.8	15.6	0.019*
Females	57.1	14.3		70.8	8.3		66.7	25.0		71.9	15.6	
Marital status												
Single	55.4	14.3		70.8	16.7		66.7	25.0		70.3	15.6	
Married /Cohabitated	57.1	14.3	0.69	70.8	8.3	0.66	66.7	16.7	0.99	70.3	15.6	0.81
Separate	53.4	10.7		66.7	12.5		66.7	25.0		68.8	10.8	
Socioeconomic status												
Middle	57.1	10.7	0.62	70.8	12.5	0.99	66.7	20.8	0.73	70.3	20.3	0,45
High	53.6	10.7		70.8	8.3		66.7	25.0		68.8	15.6	
Housing												
Own	57.1	14.3		70.8	8.3		66.7	25.0		68.8	18.8	
Rented	50.0	14.3	0.06	66.7	8.3	0,07	66.7	16.7	0.25	59.4	18.8	0.031*
Other	57.1	5.4		77.1	10.4		79.2	16.7		73.4	10.9	
Sport practice												
Yes	55.4	14.3	0.94	70.8	8.3	0.96	66.7	25.0	0.64	71.9	15.6	0.082
No	57.1	14.3		70.8	8.3		66.7	16.7		67.2	18.8	
Labor activity - Teaching/research												
No	53.6	10.7	0.019*	70.8	12.5	0.005**	66.7	16.7	0.44	68.8	15.6	0.51
Yes	60.7	14.3		75.0	12.5		75.0	25.0		68.8	18.8	
Clinical assistance												
No	NC	NC	----	NC	NC	----	NC	NC	----	NC	NC	----
Yes	57.4	12.5		70.8	8.3		66.7	25.0		68.8	17.2	
Administrative												
No	53.6	10.7	0.22	70.8	8.3	0.22	66.7	25.0	0.44	68.8	18.8	0.23
Yes	57.1	7.2		75.0	12.5		75.0	16.7		71.9	3.1	
Other												
No	53.6	10.7	0.012*	70.8	8.3	0.32	66.7	16,7	0.81	68.8	18.8	0.49
Yes	64.3	7.1		70.8	12.5		75.0	33.3		68.8	15.6	
Presence of several contracts												
Yes	55.4	14.3	0.67	70.8	8.3	0.43	66.7	25.0	0.35	68.8	15.6	0.5
No	57.1	10.7		68.8	12.5		66.7	16.7		68.8	15.6	
Written contract												
Yes	57.1	14.3	0.25	70.8	8.3	0.27	75.0	25.0	0.16	68.8	15.6	0.34
No	53.6	10.7		70.8	16.7		66.7	16.7		68.8	15.6	
Type of contract - Independent												
No	57.1	10.7	0.76	70.8	8.3	0.996	66.7	8.3	0.9	71.9	15.6	0.62
Yes	53.6	14.3		70.8	8.3		66.7	25.0		68.8	15.6	
Provision of services												
No	57.1	12.5	0.16	70.8	10.4	0.31	66.7	16.7	0.55	68.8	20.3	0.65
Yes	53.6	10.7		70.8	9.2		66.7	25.0		68.8	14.1	
Percentage rent												
No	57.1	12.5	0,097	68.8	12.5	0.6	70.8	20.8	0.64	70.3	15.6	0.37
Yes	53.6	12.5		70.8	8.3		66.7	25.0		68.8	15.6	
Temporal												
No	53.6	10.7	0.037*	70.8	12.5	0.019*	66.7	20.8	0.36	68.8	15.6	0.396
Yes	60.7	12.5		75.0	12.5		75.0	20.8		68.8	20.3	

Table 2 (continuation) - Bivariate comparison of the WHOQOL-BREF dimensions of quality of life and the qualitative variables in the study sample. Medellín, 2018 (n= 88)

Variables	WHOQOL-BREF dimensions											
	Physical			Psychological			Social			Environment		
	Me	IQR	p-value	Me	IQR	p-value	Me	IQR	p-value	Me	IQR	p-value
Average income (Colombian peso)												
3.000.001- 4.000.000	57.1	3.6	0.31	75.0	0.0	0.16	75.0	25.0	0.71	71.9	6.3	0.63
>4.000.001- 5.000.000	57.1	14.3		70.8	0.0		66.7	16.7		62.5	12.5	
>5.000.001-< 7.000.000	58.9	19.6		70.8	12.5		75.0	33.3		67.2	21.9	
> 7.000.000	53.6	10.7		68.8	14.6		66.7	16.7		68.8	15.6	
Self-rated health												
Good	51.8	14.3	0.25	66.7	10.4	0,05*	58.3	12.5	0,16	60.9	14.1	0,013*
Poor	57.1	14.3		70.8	8.3		75.0	25.0		71.9	15.6	
Social support (Duke-UNC-11)												
Normal	57.1	14.3	0.088	70.8	8.3	0.277	66.7	25.0	0.005**	68.8	15.6	0.02*
Low	42.9	14.3		66.7	8.3		33.3	0.0		56.3	0.0	
Mental health (GHQ-12)												
Good	57.1	14.3	0.004**	70.8	8.3	<0.001***	75.0	16.7	0.003**	71.9	14.1	0.001**
Poor	50.0	16.1		64.6	10.4		58.3	20.8		60.9	12.5	

Mann Whitney U test for dichotomous variables, Kruskal-Wallis test for polychotomous variables.
* p-value < 0.05 and > a 0.01 ** p-value < 0.01 and > a 0.001* *** p-value <0.001.

Table 3 - Lineal regression models for the scores of the WHOQOL-BREF dimensions of QOL in the study sample. Medellín, 2018 (n= 88).

WHOQOL-BREF dimensions	Variables included in the lineal regression model	Non-standardized Regression Coefficient	Standardized Regression Coefficient	Determination Coefficient (%)
Physical	Mental Health (Poor)	-8.5***	-0.4	21.0
	Rent housing	-8.9**	-0.3	
	Permanent contract	7.6*	0.2	
Psychological	Mental Health (Poor)	-8.2***	-0.4	25.0
	Labour activity: Teaching/ researcher	6.6***	0.4	
Social	Social support (Low)	-30.0***	-0.4	16.0
Environment	Mental Health (Poor)	-13.28 ***	-0.5	41.0
	Rent housing	-11.33**	-0.3	
	Sex (Females)	7.09**	0.3	
	Resting days per week	3.96**	0.3	
	Labour activity: Teaching/ researcher	5.8*	0.2	
	Monthly income	5.1*	0.2	

* p-value < 0.05 and > a 0.01. ** p-value < 0.01 and > a 0.001*. *** p-value <0.001.

explained between 16 percent and 40 percent of the scores obtained for the dimensions. Mental health had the most statistical weight for almost all dimensions of QOL, with a standardized regression coefficient between -0.4 and -0.5 (Table 3).

Participants' opinions and perspectives

Participants consider QOL a multidimensional and dynamic element where subjective elements of the personal and professional experience intervene as factors of the social, cultural and economic context of the country that enable the exercise of the profession and obtainment of personal, familiar and work gain (Table 4, 1a, 1b). Similarly, QOL implies the satisfaction of needs and the compliance with different expectations considered important for daily enjoyment (Table 4, 1c).

Another category is related with conditionals/determinants of QOL, which operates in positive or negative ways. Employment and work conditions of orthodontists differ among interviewees depending on the type of contract and activity (Table 4, 2a). When analyzing the specific working conditions of orthodontists who do clinical practice, they mention, for example, absence of benefits, long working hours, and emotional burden (Table 4, 2b). They also report a detriment to working conditions in terms of income (Table 4, 2c), impacting the physical and mental health situation (Table 4, 2d, 2e).

The exercise of the profession is marked by the current legislation on Social Security, and by elements of the Enforced Health Quality Assurance System that, in the opinion of the participants, has permeated in some difficulties to work in their private offices due to

Table 4 - Verbatim focus discussions groups (FDG) extracts form participants' discourses (3 FDG, n = 21).

Categories	Verbatim extracts from participants
1. Concept of quality of life (QOL)	a) *"If someone has professional success, they have all the conditions to have a better quality of life. Professional success does not necessarily mean working from 7 to 7, as I will probably be successful but won't have a good quality of life. Quality of life encompasses many things"* (FDG 2)
	b) (...) *"I think that quality of life is like a state of well-being, right? It needs to be differentiated from individual quality of life and that of, say, society or a community or a group of people or a society as the individual has aspirations, desires, anxieties as they say. As long as that is given back, I would say they have a good quality of life. At a social level, there has to be some standards that say which is the quality of life for that society and so each individual will have a way to be integrated into that society in terms of quality of life and in regards to their dreams of quality of life"* (FDG 3)
	c) *"I consider quality of life is doing everything that makes us happy and having the conditions that allow for it; staying at home if that makes me happy but doing it because I can afford it, or play sports, or travel or study but being at ease with being able to do things and do and achieve what allows me to do it"* (FDG 1)
2. Negative and positive determinants/ conditionings of Quality of Life (QOL)	a) *"I think that anyway that result can be associated to that even though we have greater mental demand -for all we have said, it is not physically that demanding whereas when you work as an orthodontist the physical demand is greater while the mental one is, say, may not be so high. As teachers, anyway, I think we all choose to be here since it gives us a level of satisfaction as we are not expecting further retribution other than being happy with what we do. I also share that being professors demands more time outside the work place"* (FDG 3)
	b) *"I would love to have social benefits and saying for once in my life that I will have a smooth December. For me December is torture because it means paying all December-related and January expenses without having the money because people chooses not to go to treatments and so I am like "come let's work until Christmas"*(FDG 1)
	c) *"Financially, I don't think being an orthodontist is profitable these days. To have high income you need to work very hard and long hours, to achieve that balance"* (FDG 3)
	d) (...) *"we have spoken about muscle-skeletal disorders. We are very exposed to them. Obviously as more patients, greater the risk of having some health issue that will affect work performance and quality of life"* (FDG 3)
	e) (...) *"It makes me laugh because one day we met, all the female alumni from Universidad de Antioquia, mostly from orthodontics, and they began to talk... all went to the same therapist! They had to see a therapist because it was hard to cope with day-by-day activities and stress. All, because of their personality type, began a zero-stress program... not stressing over things you cannot control as traffic jams. As they say around here a lot, light one and relax as you arrive, and all that"* (FDG 1)
	f) *"I think that for myself, it is just a mystery because when the control body announces a visit everyone is stressed, at least from two months before. For me... I don't see any more than external pressure; the pressure on the professional"* (FDG 2)
	g) *"One thing we have not covered is that the health system is also affecting us, particularly orthodontists. For example, a dentist thinking about opening a practice. From 150 graduating, 10 opened their private practice and most are thinking about finding work. That is also seen in specialists when other entities are beginning to cover specializations of dentistry, they also will absorb the demand and we will obviously see the amount of patients decrease from the private practice. That will impact the level of income because health service providers are absorbing it"* (FDG 3)
	h) *"I agree with that payment is not the same but satisfactions are greater since we work better each time. Each time we have more experience, because each time we manage people better"* (FDG 2)
3. Proposals and strategies for improving QOL in orthodontists	a) *"Here is a point I find very important, what he says. Our programs, as I understand, in other countries students up to their 20's, or the first third of their lives, are taught economics, administration and we are ignorant in those fields. We charge for what we observe but we do not know why. Besides we don't know how to invest what we make. They are prepared for that so when they go out to the productive life they already know what to do with their money. We don't have that clear"* (FDG 2)
	b) *"We talked about it once, as (name of the person) said, doctors saw a way to organize themselves, We do not know how to be organized towards the same goal. If we all fought in the same direction this would be different".* (FDG 2)
	c) (...) *"I had to make a bunch of changes in work-hours, pause, join the gym, strengthen my back, abdomen... I even stop exercising for over a month and the body claims it. I begin work and the back feels warm and I know I have to start back exercises".* (FDG 1)

operating requirements (Table 4, 2f, 2g). High market competition is referred to by orthodontists graduated from other universities in the city and the country and from general dentists who perform low cost orthodontics (Table 4, 2g).

Participants mentioned some satisfaction of QOL as, for example, saving for the future, family support, teaching, support networks as, in this case, the association of orthodontists. Similarly, the positive transformation resulting from graduate schooling is highlighted as mind-opening as it gives them satisfaction as they consider their job useful to society (Table 4, 2h).

Interviewees present a series of proposals to improve QOL. First, they mention some strategies to be implemented in graduate school: financial education, administrative aspects, enterprise creation and entrepreneurship (Table 4, 3a). The importance of associations is highlighted as a strategy to attain common objectives as orthodontist in exercise of the profession, as compared with other professions with more guild experience (Table 4, 3b). Lastly, they refer some individual strategies as, for example, time management, promotion of health and spare time (Table 4, 3c).

Understanding individual, social and contextual factors influencing QOL in orthodontists: a conceptual explicative framework

Figure 1 shows the conceptual framework to understand several factors related to QOL from the participants' perspective. QOL appears as a multifactorial construct based on personal and professional subjective experiences, in sociodemographic, labor and social characteristics and all influenced for the political, social and economic context of the country.

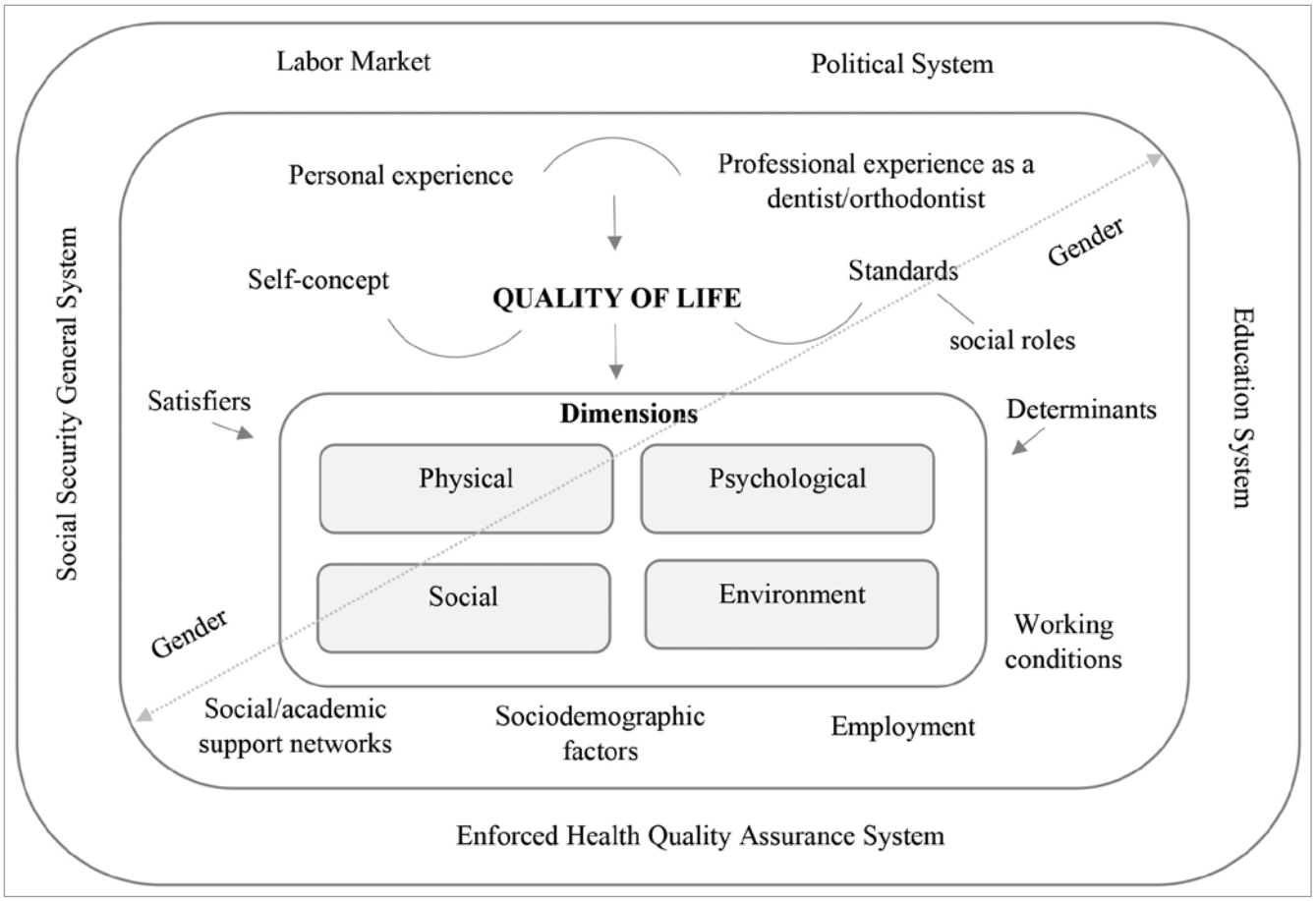

Figure 1 - Conceptual explanatory framework for QOL in orthodontists according to quantitative and qualitative findings.

Supplementary Table - Sociodemographic, labour, health and quality of life variables in the study sample. Medellín, 2018 (n=88).

Variables	n (%)
Sociodemographic	
Sex	
Males	42 (47.7)
Females	46 (52.3)
Age[a]	
Mean (± SD)	42.2 (7.1)
Marital status	
Single	26 (29.5)
Married / Cohabited	55 (62.5)
Separate	7 (8.0)
Socioeconomic status	
Middle	24 (27.6)
High	63 (72.4)
Housing	
Own	69 (78,4)
Rented	11 (12.5)
Other	8 (9.1)
Vehicle	
Yes	80 (90.9)
No	8 (9.1)
Type of family[c]	
Nuclear	62 (72.1)
Extended	5 (5.8)
Single-parent	3 (3.5)
Assembled	1 (1.2)
Live alone	15 (17.0)
Number of people in charge[a]	
Median (IQR)	1.0 (2.0)
Labour conditions	
Laboractivity[b]	
Teaching/research	27 (30.7)
Clinical assistance	88 (100.0)
Administrative	9 (10.2)
Other	2 (2.3)
Written contract	
Yes	57 (64.8)
No	31 (35.2)
Presence of several contracts	
Yes	51 (58.0)
No	37 (42.0)
Type of contract[b]	
Permanent	9 (10.2)
Temporal	16 (18.2)
Independent	62 (70.5)
Provision of services	52 (59.1)
Percentage rent	53 (59.1)
Percentage rent value[a]	
Median (IQR)	60.0 (20.0)
Working hours per week[a]	
Mean (± SD)	38.9 (12.0)
Resting days per week[a]	
Median (IQR)	2.0 (1.0)
Working geographical regions[b]	
Metropolitan area	78 (88.6)
Intermunicipal	63 (71.6)
Interstate	2 (2.3)
Average income (Colombian peso)[d]	
3,000.001 - 4,000.000	5 (5.7)
> 4,000.001 - 5,000.000	9 (10.2)
> 5,000.001 - < 7,000.000	16 (18.2)
> 7,000.000	58 (65.9)
Number of work places as an orthodontist[a]	
Median (IQR)	4.0 (3.0)
Does your current salary allow you to cover your basic needs, and those of the people who depend on you?	
Yes	80 (90.9)
No	8 (9.1)
Does your current salary allow you to cover unforeseen important expenses?	
Yes	66 (75.0)
No	22 (25.0)
Training and unformal education[b]	
Diploma courses	33 (37.5)
Short courses	78 (88.6)
Congress	86 (97.7)
Conferences	67 (76.1)
Other	4 (4.5)
Annual frequency of participation in events of training and unformal education[a]	
Median (IQR)	3.0 (3.0)
Quality of life	
Physical[a]	
Median (IQR)	57.1 (10.7)
Psychological[a]	
Median (IQR)	70.8 (8.3)
Social[a]	
Median (IQR)	66.6 (25.0)
Environment[a]	
Median (IQR)	68.7 (18.7)
Health	
Sport practice	
Yes	58 (66.0)
No	30 (34.0)
Body Mass Index (BMI)[a]	
Mean (± SD)	24.1 (3.4)
Self-rated health[c]	
Good	71 (85,5)
Poor	12 (14.4)
Social support (Duke-UNC-11)	
Normal	83 (94.3)
Low	5 (5.7)
Mental health (GHQ-12)	
Good	68 (77.3)
Poor	20 (22.7)

[a] Kolmogorov-Smirnov test for Normality. Variables with normal distribution: Age (years), BMI and Working hours per week. [b] Non-mutually exclusive percentages. [c] Missing values: Type of family (n= 2), Self-rated health (n= 5). [d] 1 US dollar = 3,100 Colombian peso.

DISCUSSION

This study analyzed the influence of socio-demographic and job characteristics on QOL of orthodontists graduated from a public university in Medellin (Colombia). Main scores surpassed 55 points on the four domains of WHOQOL-BREF, which suggest a good quality of life of the population studied. In spite of that, a lower value is found in the physical dimension and a greater value in the psychological dimension. In relation to such results, a study on dentistry specialists with QOL using the same instrument revealed a better value in the social and psychological domains and lower value in the environmental domain.[8] Another study on dentists showed high QOL in the physical and psychological domains, and a lower value in the environmental domain.[5] The variability in findings could be explained according to the social and economic setting of the analyzed studies.

In spite of the heterogeneity of results, it is possible to think that variability in score in the environmental domain measured by WHOQOL-BREF, as found between the studies, is due to uneven conditions in factors related with financial resources, safety, health, social assistance and opportunities for recreational activities of each population.[10] The finding related with lower QOL value in the physical domain, which measures categories related with energy, fatigue, pain, discomfort, sleep and rest, could be related to a degree with the effects inherent to the exercise as orthodontist, including musculoskeletal disorders, which are highly reported by dentists,[18] thus affecting QOL and reducing work productivity. Reported risk factors at work include working in the same or in uncomfortable positions for long periods of time and seeing an excessive number of patients a day.[19]

The psychological domain presents a higher value in the group studied, which measures aspects related to body image, appearance, negative and positive feelings, self-esteem, thoughts, apprenticeship, memory and concentration. This result concurs with other on QOL of dentists in teaching hospitals, showing that becoming a specialist has a positive impact in the QOL in the psychological domain.[9] Graduate school can undoubtedly influence the level of self-esteem and improve positive feelings in an individual.[9] Furthermore, it was found that dentists with a postgraduate degree have higher levels of overall professional satisfaction which can positively influence QOL.[22,23]

Being an orthodontist was considered by FDG as not monotonous as it exercises thinking and integrates creativity and skill, having a positive impact on the psychological dimension. Even though there were no quantitative comparisons of QOL of orthodontists and general dentists, it came out in the FDG where specialists report an improvement in their QOL since becoming specialists. This was reported by another study where the differences in QOL and in the work satisfaction of the specialist are evident as the specialist focuses on the specialty and has the opportunity to collaborate with other in the field in different forum and associations, and financial rewards are also greater as compared with dentists.[10]

Even though historically male and female have taken different roles and responsibilities in regard to work and family education, studies have reported that the practice of female orthodontists is not significantly different from male.[24] The present study makes evident better QOL of female in the environmental domain, despite the multiple responsibilities besides the profession. A qualitative study on female orthodontist reports that satisfaction with their personal and professional roles is related with the need to commit to and prioritize activities for the accomplishment of family-work balance, finding adaptations both on maternity and the professional roles.[25]

Among the factors related with working conditions of orthodontists, the influence of work-hours and days-off per week in the environmental domain of QOL was identified. In an international-scope study on orthodontists, it is reported an average of 30 work-hours per week,[23] and the present study estimates an average of 39±12 work-hours per week. The equitable distribution of work and rest times accounts for the equilibrium between personal and work life mandatory for a good QOL, despite the multiple factors that may affect this balance.[26] Dentistry and its specialties are autonomous professions hence the decision to distribute time will depend on the free choosing of the professional, conditioned by their needs and the environment.[26] Also work dissatisfaction of orthodontists has been reported on aspects related with management of the practice and the amount of personal time, reinforcing the influence of work conditions on work satisfaction and consequently QOL.[27-30]

In this study, activities of teaching/researching positively influenced QOL in the physical and psychological dimensions. Possibly, these results are related with the lower physical demand and less time of clinical practice, which reduce exposure to risk factors and positively influence attributes of recognition, concentration and learning as aspects measured in the psychological dimensions of WHOQOL-BREF.[16,20] In the FDG of professors of orthodontics is discussed that despite the economic retribution received from teaching, as is lower than income from clinical practice, the activity is better valued as they are allowed to communicate their knowledge, learn and stay updated. A similar study on professors of orthodontics reported multiple reasons to enter academia: desire to teach, opportunity to mentor, research, advisory and returning to the specialty.[29]

The greater predictor of QOL in the domains surveyed, except social relationships, was mental health being better the QOL score when reported as good. Working in a dental practice is known as physically and mentally demanding, which can generate chronic stress and affect the mental health of the professional.[10,31,32] Furthermore, it has been described that professional exhaustion eventually leads to both mental and emotional burnout, and may end in a negative attitude both in the professional and personal scopes, affecting the overall health of the individual.[31,32] From the opinions of orthodontists part in the FDG emerge ideas related with the concept of work stress as a factor affecting QOL that cannot only influence the psychological but also the physical dimensions.

Limitations of the present study include the rate of response of participants and conformation of FDG. This may affect the results of the study as the decision to reply the survey or participate in focus groups may be related with perceptions of their quality of life and family and work conditions. Similarly, the sampling selection makes generalizing conclusions about all the population of orthodontists at regional and national levels, since we included graduated specialists from one public University in Medellín. Further research should consider other orthodontists from other universities in Colombia, in order to make regional comparisons and offer a general view of the factors affecting the QOL of orthodontist in all country.

Accepting the above limitations, this study adds to the existing literature an exploration of the factors influencing the QOL in an important group of orthodontists through a newfangled approach (mixed methods). Further research for the orthodontic community should be focused on exploring new elements that are related to the QOL in working and social spaces. For example, to explore the contextual and social determinants of some physical and mental diseases affecting the personal and labor life in orthodontists (musculoskeletal disorders, professional burnout), since the scientific evidence in Colombia about the topic is scarce. Similarly, multiplicity of factors associated with dimensions of QOL make evident the particularities of their distribution in the subgroups, its multifactoriality and the need for intersectoriality and interdisciplinarity for its attention, promotion or research. Finally, universities and scientific societies can offer professional training in order to improve quality performance of orthodontists.

CONCLUSION

It is evident that there are several factors associated with a greater predictive potential for QOL in the orthodontists through different domains. The features that had the greatest influence in a positive way were: permanent contract, teaching/research activities, monthly income, resting days per week and sex. Conversely, characteristics associated negatively were low social support, mental health and rent housing. This explains the multidimensional nature of QOL in this population and corroborated for the conceptual framework that permitted to identify several social and contextual factors influencing QOL from personal and professional perspectives.

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