

***Periodontium* and Orthodontic Implications: Clinical Applications**

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Abstract Clinically, in periodontally susceptible or compromised patients who present malocclusion, the orthodontic intervention can be only initiated when the periodontal inflammatory/infectious process is controlled and stable periodontal condition is achieved. Periodontal microbiota control is achieved throughout elimination or significant reduction of periodontal pockets. After the periodontal treatment has been performed, the orthodontic treatment provides clear benefits in order to achieve and maintain such periodontal homeostasis.

Keywords Periodontics, Orthodontics, Clinical Assessment, Periodontal Treatment, Orthodontic Treatment

1. Introduction

If the orthodontic movement is applied in a periodontal inflammatory/infectious process active state, there is a significant increase of the risk of insertion loss and bone loss. Furthermore, if the periodontal inflammatory/infectious process returns to its active phase during the orthodontic treatment, the orthodontic movement *per se* is risky, and such risk might be accentuated by the compulsory occlusal trauma involved in the orthodontic correction process.

Orthodontically, even without any periodontal disease installed, a lousily diagnosed or conducted treatment is a facilitator for its installation, especially when the patient oral hygiene is explicitly deficient. It becomes clear that the integration between Orthodontics and Periodontics, especially in adult patients, is mandatory.

In the modern and serious dental practice, such synergy is fundamental. Besides systemic variables, genetic heritage, age, collaboration, correct and complete diagnosis and good execution, the factor that is explicitly mentioned in the literature as a must for success of the orthodontic therapy and of the periodontal therapy is the patient adequate oral hygiene.

2. Goal

Based upon scientific evidences, specialists can predict which clinical results are expected and, in the clinic, to achieve them. Moreover, specialists shall prognose middle and long-term results, with the responsibility that the

professional and the patient wish to have.

3. Orthodontic Treatment in Periodontally Susceptible or Compromised Patients

Under severe control against formation of dental biofilm and elimination or surveillance of periodontal pockets, patients who present susceptible or compromised periodontal status can be submitted to orthodontic treatment.^{23,10,55} Moreover, the orthodontic treatment allows that the stable periodontal status is maintained.^{12,3738,43,23}

Although there is no clear correlation between malocclusion and periodontal disease,³² or between the effects of orthodontic treatments on periodontal improvement,⁶⁰ the literature describes clear interaction between Orthodontics and Periodontics.

Probable contributions of Orthodontics in the Periodontics field are:

1) It allows better oral hygiene by the patient, since it provides well shaped dental arches. Without dental crowding, malocclusion as a periodontal disease facilitator is eliminated;

2) It allows vertical occlusal impact parallels to the long axes of the teeth. Therefore, the applied muscle force is uniformly distributed all over the dental arch;

3) It contributes, along with prosthetic rehabilitations, for a normal vertical dimension;

4) In selected cases, it allows that the adequate dental crown-root relationship is achieved with induced orthodontic extrusion, with no bone loss;

5) It facilitates that bone vertical defects are corrected or improved with dental uprighting;

6) It improves the positioning of prosthetic pillars for fixed prostheses and of the next teeth of osteointegrated

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implants;

7) It decreases or eliminates effects of bruxism, as pain or muscle spasms, during the orthodontic therapy;

8) With the current available orthodontic technology and with correct planning and execution, it allows precise, light and efficient orthodontic movements.

Summarizing, when the periodontal inflammatory/infectious process is controlled and the periodontal health is stabilized, the orthodontic treatment is indicated. However, orthodontic movements in periodontal susceptible or compromised patients in active status of inflammation/infection increase significantly the risk of loss of attachment and of bone loss. In extreme cases, they can provoke periodontal collapse and condemnation of the teeth to extraction.

The key point for successful integration of orthodontic treatment with periodontal treatment is maximum attention to the inflammatory process, its history and its prognosis. "Orthodontic inflammation" must be preserved in a "normal" level throughout the treatment and after its conclusion. If the periodontal inflammation/infection is already active before the orthodontic treatment or relapses to its active status during the orthodontic treatment, the orthodontic movement is *per se* threatened,^{92,93} and such risk can be aggressively accentuated by the occlusal trauma compulsorily involved in the process.

Similarly, in cases that there is no installed periodontal disease, a lousily planned or wrongly conducted orthodontic treatment becomes an important factor for the installation of the periodontal disease, especially if the oral hygiene of the patient is explicitly deficient. However, if the orthodontic treatment is well planned and addressed and the patient preserves good oral hygiene, there will be no periodontal disease installation.

During orthodontic treatment, periodontal health can be maintained independently of the width of the present keratinized gingiva,^{15,40,92} although the thickness of the attached gingiva may plan an important role in this process.⁹² Such results are controversy with the results of other authors,^{18,75} which stated that when the attached gingiva is larger, it is more "resistant" to iatrogenic effects that the orthodontic treatment may cause. In reality, the divergence among opinions is mainly due to methodological differences between research designs.

The whole periodontal *apparatus*, including bone, periodontal ligament and soft tissues, is remodeled with orthodontic treatment.⁵ The laminate alveolar bone suffers resorption on the pressure side and deposition on the tension side^{68,69} and compression of the periodontal ligament provokes the squeezing of the vessels and important decrease in its blood supply.

If the orthodontic pressure is excessive and localized, it may occur a deleterious hydrostatic pressure in the periodontal ligament,³⁵ potentially increasing the risk of root resorption.³⁶ Besides that, there is important variability in the response of periodontal tissues facing different types of orthodontic movement. Movements of vestibular flaring

might be more dangerous to connective tissue attachment loss and bone loss.^{2,24,75}

With aging, periodontal tissues become richer in collagen and present diminished blood supply. Consequently, the periodontal response to orthodontic forces slows down and hyalinization zones are more commonly established.⁵⁴ When hyalinization of the tissue occurs, the dental movement is paralyzed and a complex reparative process is installed. The orthodontic movement proceeds when the repair process is concluded.

Due to tissue and metabolic differences observed between teenagers and adults during orthodontic treatment,⁵⁰ it is recommended a longer retention period for adults. Moreover, in adult patients, since their response power is decreased, there is greater risk that deleterious effects of wrongly addressed orthodontic treatments are more significant and quickly observed. As an example, lack of adequate repair³⁰ allows significant bone resorption in the vestibular *laminae* when orthodontic forces have exceeded the capability of response of the periodontal tissues.^{66,84}

4. Occlusal Trauma

There is no consistent evidence that occlusal trauma provokes attachment losses and bone losses when *periodontium* is healthy.^{45,58} However, when periodontal disease is installed, unbalanced occlusion may aggravate it.⁵⁷ Therefore, occlusal trauma might be considered an aggravator factor of periodontal problems, although not necessarily a causal factor for its occurrence.⁵⁹ Para-functional habits and important interferences in excursive mandibular movements may be also deleterious to the periodontal status.¹³ Occlusal interferences that promote dental "jiggling" aggravate attachment losses and bone losses.²⁸ Besides that, they significantly decrease potential re-attachment after periodontal treatment. Clinically, comprehensive assessment and occlusal adjustments are mandatory.⁶⁴ It does not matter if it is performed by the orthodontist or periodontist.

5. Orthodontic Movement Relapse

Some orthodontic movements are more susceptible to relapse. A good example is dental rotation, a movement that is relatively easy to get but hard to be maintained, due to the positioning of the dento-gingival and dento-alveolar fibers. Moreover, the presence of oxytalan fibers, similar to elastic fibers, in the supra-bone crest gingival tissue,^{29,33,71,74} increases the risk of relapse of rotational movements. However, few clinical studies have comprehensively assessed such problem.^{21,47,14}

With orthodontic movement, the fibers are maintained "twisted" and dental retention must be imposed up to their full re-insertion. If the new dental position is not full time maintained for a period of 03 to 06 months^{67,3,19,77,78} and part time for 12 months,⁶³ is very probable that the tooth(teeth)

return(s), totally or partially, to its original position.^{67,51} Overcorrection of dental rotation is recommended.⁴⁴

Supra-bone crest fibrotomy promotes the resection of the circular and interproximal collagen fibers^{67,20,22} and the procedure is recommended to be performed before orthodontic interventions, intending to decrease or eliminate potential relapse of rotational movements. Evolution of orthodontic relapse in cases submitted to circumferential fibrotomy with follow-up of 15 years has been studied.²² Significant decrease in the relapse occurrence was observed in the cases submitted to fibrotomy, especially in regard to the rotational dental movement of the anterior upper teeth. As positive points of its application, it was not found significant differences between the experimental and control groups in regard to the gingival sulcus deepness neither in regard to epithelial re-attachment in the periods of 01 and 06 months after supra bone crest fibrotomy.

6. Root Resorption After Orthodontic Treatment

Orthodontic movement occurs throughout an inflammatory process. The local scenario and the degree of intensity and duration of such inflammation are directly related to the possibility of root resorption.⁹ However, a causal relationship between orthodontic force and root resorption has not been proofed yet.

It is known that, the most of the time, root resorption is an orthodontic collateral effect: irreversible, painless, quick, with obscure prognosis, weakly controlled and, when radiographically detected, it might have already achieved devastating proportions. Different degrees of severity of root resorption have been carefully described.^{80,81}

In general, when confined to *cementum*, root resorption is reversible. However, when the dental root also losses dentin, what occurs with certain frequency in the apical area, the process becomes irreversible. Dental ankylosis is not a frequent consequence of the root resorption process.

Root resorption can be idiopathic⁷⁰ and can occur in 10% of the patients that has never been orthodontically treated.³⁴ In such patients, 1% to 2% presents severe root resorption, especially in upper incisors. Therefore, certainly there are other systemic (and perhaps genetic) also involved in the root resorption process.¹¹ There is not systematic root shortening that naturally occurs with aging,⁷ and detected root resorption can be stabilized and successfully controlled for long periods of time.^{56,17}

7. Orthodontically Induced Extrusion

It has been known that gingival tissues significantly follow dental movements.⁵ Orthodontically induced extrusion, originally described as forced eruption,³⁷ aims to increase the size of the clinical crown and/or change the height of the free gingival margin.^{79,5} And also aims to

increase (or to remodel) the alveolar bone crests of the extruded tooth and its adjacent ones, since the relationship between the enamel-*cementum* junction and its bone crests is roughly maintained. Induced extrusion can be also applied in condemned teeth, previously to the installation of fixed prostheses with pontics or dental implant placement.⁷²

The periodontal reactions in monkeys which upper incisors were submitted to induced extrusion were analyzed.³⁹ It has been concluded that if oral hygiene is well controlled, the deepness of the gingival sulcus is maintained, and there is no periodontal pocket formation or significant inflammation. The attached gingiva moves approximately 80% of the vertical dental movement and the mucosa-*gingival* junction does not suffer major change. However, there is potential risk for relapse and application of fixed permanent or semi-permanent retainers is recommended.²⁷

Possible gingival recessions during extrusive movements in animals is not due to the dental movement, rather is due to the poor hygiene control of the related teeth and such factor must be definitively considered.^{86,85,25,26,31,28,48,82}

It has been presented an experimental model in dogs to assess the periodontal response of induced orthodontic extrusion,⁵ with and without fibrotomy of the dento-supra-bone crest attachment gingival fibers. Induced extrusion without fibrotomy was followed by bone remodeling, increase of the width of the attached gingiva, bone deposition in the bone crests and some gingival margin recession. With fibrotomy of the dento-*gingival* fibers, extrusion was significantly greater, as gingival recession and the attachment loss of the connective tissue. Such results agree with other results^{61,42} in regard to the lack of coronal displacement of the gingiva and no bone deposition on the bone crests when fibrotomy is performed. Moreover, such results agree with other clinical^{37,38,76,42,62} and experimental results.^{73,79}

Induced orthodontic extrusion with fibrotomy of the supra-*gingival* fibers is indicated in clinical crown lengthening, without any osteotomy in the bone alveolar crests^{16,66} and might be a good alternative to address vertical periodontal defects.⁶²

8. Induced Orthodontic Intrusion

Induced orthodontic intrusion may be indicated in cases that teeth have suffered horizontal losses is their bone crests or present periodontal pockets. However, the orthodontic mechanics is rarely applied parallel to the long axis or in the long axis of the related teeth and its benefits are controversial. When oral hygiene is well controlled, the use of intrusive orthodontic forces might promote desirable periodontal changes.⁴⁸ Orthodontic movements must be delivered throughout light forces.⁴⁹ When oral hygiene is deficient, the intrusive movement may facilitate the presence of dental biofilm in the sub-*gingival* region, provoking or aggravating the ongoing process of periodontal destruction.²⁴⁻²⁷ Gingival position partially follows induced orthodontic intrusion.^{41,8,52}

9. Molars Uprighting

Correction of dental positioning is a potential contribution of Orthodontics to improve the periodontal status of a patient, although it is secondary to dental biofilm control and surveillance of the periodontal bacterial colonization. The mesial inclination of second molars, especially lower ones, due to premature losses of first molars, is a routine clinical fact. Such mesial inclination is an aggravator factor for

installation of localized periodontal disease, due to the difficulty of adequate hygiene in the mesial portion of the inclined tooth. Orthodontic uprighting is broadly presented as a welcome solution to decrease or to eliminate installed periodontal problems. However, correlations between mesial inclination, pocket formation and its improvement or elimination after orthodontic treatment have not been presented.^{41,46}

Table 1. Top 10 most scientifically relevant articles of the paper. *Clinical Evidence

Year	Main Author	Title	Main Conclusions	Clinical Evidence
1988	Artun J	The effect of orthodontic treatment on periodontal bone support in patients with advanced loss of marginal periodontium.	Loss of periodontal bone support was examined in orthodontically treated patients. Prior to orthodontic treatment, the patients had received periodontal treatment. No association was found between initial bone loss and bone loss during orthodontic treatment.	*
1997	Beertsen W	The periodontal ligament: a unique, multifunctional connective tissue.	The periodontal ligament links the teeth to the alveolar bone proper, providing support, protection and provision of sensory input to the masticatory system.	No
1989	Boyd RL	Periodontal implications of orthodontic treatment in adults with reduced or normal periodontal tissues versus those of adolescents.	The periodontal status in 20 adults and 20 adolescents undergoing fixed orthodontic treatment was monitored. For loss of attachment, there were no significant differences among adolescents, adults with normal periodontal tissues and adults with reduced but healthy periodontal tissues.	*
1993	Harris EF	An analysis of causes of apical root resorption in patients not treated orthodontically.	Root resorption was significantly more common in teeth with compromised support. Loss of stability from adjacent teeth, increased use of fewer remaining teeth, and loss of the root's anchorage in the bone are significant predictors of external apical root resorption.	*
1989	Melsen B	Intrusion of incisors in adult patients with marginal bone loss.	Intrusion was best performed when forces were low (05 to 15 gm per tooth) with the line of action of the force passing through or close to the center of resistance, the gingival status was healthy and no interference with the perioral function was present.	*
1997	Nelson PA	Alveolar bone loss of maxillary anterior teeth in adult orthodontic patients.	The prevalence and severity of alveolar bone loss in adult orthodontic patients was studied. No association between bone loss and length of treatment, post-treatment gingival appearance, amount of horizontal and vertical tooth movement were found.	*
1988	Polson AM	Long-term periodontal status after orthodontic treatment.	The study evaluated the clinical periodontal status of persons who had completed orthodontic therapy at least 10 years previously. Orthodontic treatment during adolescence had no discernible effect upon later periodontal health.	*
2000	Re S	Orthodontic treatment in periodontally compromised patients: 12 year report.	The orthodontic treatment in not contraindicated in patients who present severe adult periodontitis. In these cases orthodontics improve the possibilities of saving and restoring a deteriorated dentition.	*
1995	Wehrbein H	Human histologic tissue response after long-term orthodontic tooth movement.	The maxilla of a deceased 19 year-old young woman who had been orthodontically treated was removed during autopsy. Histologically, bony dehiscences and fenestrations in the facial and oral cortical plates were verified. They could not be diagnosed by radiographs and by macroscopic inspection of the specimen.	No
1993	Wennström JL	Periodontal tissue response to orthodontic movement of teeth with infrabony pockets.	Orthodontic therapy involving bodily tooth movement may enhance the rate of destruction of the connective tissue attachment at teeth with inflamed, infrabony pockets and the risk for additional attachment loss is particularly evident when the tooth is moved into the infrabony pocket.	No

10. Pathological Dental Migration

Losses of attachment of connective tissue and bone losses may imply in vestibular flaring of anterior teeth and consequent opening of diastemas. With the periodontal disease is installed, loss of periodontal support enhances the effects of occlusal trauma, especially in mandibular excursions, provoking quick and significant flaring of the anterior teeth with important loss of anterior vertical dimension.

With orthodontic treatment and maintenance of its results, the periodontal status is stabilized and bone losses are significantly reduced.¹ In studies of large scale the benefits of orthodontic treatment for establishment of a stable periodontal scenario, independently of the applied orthodontic technique, has been confirmed.^{53,65}

11. Conclusions

As the orthodontic treatment of periodontal health patients, the orthodontic treatment of periodontal susceptible or compromised patients is multi-factorial. Besides systemic variables, genetic potential, age, patient compliance, complete and correct diagnosis/good planning /good professional execution, the factor which is consistently reported in the literature as mandatory for therapeutic success is an adequate oral hygiene.

Periodontal microbiota control is achieved throughout elimination or significant reduction of periodontal pockets, efficient and constant professional follow-up and good personal oral hygiene. Moreover, the literature reports clear evidence of the benefits of the orthodontic treatment application to achieve and to maintain the periodontal homeostasis.

In the table 1 the main results of the most scientifically relevant articles of the present paper are summoned. Furthermore, we present to the dental community the value of the "ortho-periodontist"; which means, the orthodontist who comprehensively assess the periodontal status of a patient and knows the possibilities and limitations that the periodontal therapy offers. Moreover, the value of the "perio-orthodontist", which means, the periodontist who wants to proportionate the best possible therapy to the patient, also including all the benefits that the orthodontic treatment may provide. Such professionals are not professionals of the future, they are professionals of the present. They are professionals that, independently of any academic classification, provide to patients "Excellence in Dentistry".

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