

---

# Periodontal Health and Orthodontics

---

Mourad Sebbar, Zouhair Abidine,  
Narjisse Laslami and Zakaria Bentahar

Additional information is available at the end of the chapter

<http://dx.doi.org/10.5772/59249>

---

## 1. Introduction

The most common objectives of an orthodontic treatment are facial and dental aesthetics and the improvement in the masticatory function. There is a continuously increasing number of adult patients who actively seek orthodontic treatment, and it is also an undeniable fact that the incidence of periodontal disease increases with age. Therefore, the number of patients with periodontal problems that attend orthodontic practices is significantly greater than in the past [1].

There are many links between periodontology and orthodontics. After all, every orthodontic intervention has a periodontal dimension: orthodontic biomechanics and treatment planning are basically determined by periodontal factors such as the length and shape of the roots, the width and height of the alveolar bone, and the structure of the gingiva [2].

The main objective of periodontal therapy is to restore and maintain the health and integrity of the attachment apparatus of teeth. Additionally, orthodontic therapy can facilitate management of several restorative and aesthetic problems relating to fractured teeth, tipped abutment teeth, excess spacing, inadequate pontic space, malformed teeth, and diastema.

Generally, the main reasons routinely cited to justify the provision of orthodontic treatment are improvement of facial and dental aesthetics and of dental health and function. However, association between malocclusions and periodontal condition is still controversial [3].

Ngom [4] found significant correlations between malocclusions and periodontal condition and suggested that malocclusions are risk markers for periodontal diseases. However, a real inference about a cause/effect relationship between malocclusions and periodontal condition in this study was not possible.

A review of the literature conducted by Van Gastel [5] showed contradictory findings on the impact of malocclusion and orthodontic appliances on periodontal health, since only a few studies reported attachment loss during orthodontic treatment. It has been suggested that this contradiction may be partly due to the selection of materials and differences in the research methods employed [6].

All evidence-based literature concerning the orthodontic-periodontic relationships show that a good orthodontic treatment of patients, who have excellent oral hygiene and do not suffer any periodontal breakdown, is a non-harmful treatment for the periodontium, it has been also demonstrated that a diminished oral hygiene in corporation with periodontal disorder would make the orthodontic treatment a real high risk for the periodontium [7,8].

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 [9].

A multidisciplinary approach is often necessary to treat and prevent dental problems in patients. This chapter will address basic considerations for orthodontists as well as periodontists for successful outcome of various treatments. Several clinical cases will be presented to illustrate the orthodontic-periodontic relationships.

## **2. Orthodontic treatment and oral hygiene**

A high standard of oral hygiene is essential for patients undergoing orthodontic treatment. Without good oral hygiene, plaque accumulates around the orthodontic appliance, causing gingivitis and, in some cases, periodontal breakdown. To avoid such problems, the orthodontist has a double obligation: to advise the patient about methods of plaque control and, at routine visits, to monitor the effectiveness of the oral-hygiene regime. However, despite receiving appropriate advice, many patients undergoing orthodontic treatment fail to maintain an adequate standard of plaque control. It is important that the orthodontist is able to communicate the importance of oral hygiene to motivate patients to maintain a satisfactory standard of oral hygiene during orthodontic treatment [10].

Before any orthodontic treatment an initial diagnosis and referral for treatment to control active periodontal disease is to be considered. Moreover, all general, dental and periodontal treatment should be completed before the orthodontic treatment. Once the orthodontic appliances are placed, the patients need to be instructed in how to manage the new oral environment and how to maintain the health of the dental and periodontal structures. The orthodontist has to provide the patient with initial brushing instructions with either a conventional toothbrush or a powered one when the appliances are first placed. However, if the orthodontists correctly advise their patients to follow proper oral hygiene instructions during the orthodontic treatment is still an opened question.

Manual tooth brushing, one of the oldest methods of plaque removal, remains the basis of oral hygiene and plaque control. It is often used as the standard or control against which other methods of plaque removal are assessed [10,11]. Instruction should emphasize the need to use sufficient pressure to remove plaque; a pressure sensitive toothbrush would be a valuable aid to patients undergoing orthodontic treatment.

Chlorhexidine mouthwashes, as an adjunct to tooth brushing, have been found effective in the control of gingival inflammation [12], although prolonged use may cause problems with staining as Chlorhexidine rinses can potentially stain the margins of composite restorations that cannot be easily removed. More recently, pre-brushing rinses have been introduced, though these show no differences in effect on plaque accumulation or gingival health [13]. Chlorhexidine is also useful for patients after orthognathic surgery, especially when inter-maxillary fixation is to be used.

On the other hand, Fluoride mouth rinses significantly reduce the extent of enamel decalcification and gingival inflammation during orthodontic treatment [13.14]. A number of studies evaluated the effect of mechanical aids, as compared with manual tooth brushing, on oral hygiene in orthodontic patients [11.12] and it has been shown that the use of electric toothbrushes brought a significant improvement in oral hygiene. The orthodontist can follow some suggestions in order to improve plaque removal by the patient. Bonding of molars results in better periodontal health than banding. Whenever possible the use of single arch wires is recommended. The removal of excess composite around brackets, especially at the gingival margin, and avoiding the use of lingual appliances whenever possible are also important ideas in order to keep healthy periodontal tissue during any orthodontic treatment.

### **3. Periodontal tissue and orthodontics**

#### **3.1. Periodontal tissue and orthodontic forces**

Tooth movement during orthodontic therapy is the result of placing controlled forces on teeth. Removable appliances place intermittent tipping forces on teeth while fixed appliances can create continuous multidirectional forces to create torquing, intrusive, extrusive, rotational and bodily movement [15.16]. Bone surrounding a tooth subjected to a force responds in the following manner: resorption occurs where there is pressure and new bone forms where there is tension. When pressure is applied to a tooth, there is an initial period of movement for six to eight days as the periodontal ligament (PDL) is compressed. Compression of the PDL results in blood supply being cut off to an area of the PDL and this produces an avascular cell-free zone by a process termed "hyalinization". When hyalinization occurs, the tooth stops moving. Once the hyalinized is removed, tooth movement can occur again [16.17].

#### **3.2. Mechanisms of tissue damage**

Unfestooned orthodontic bands are particularly suspects as possibly complicating factors jeopardizing interproximal periodontal support, and at the present time "special periodontally

friendly bands” are being designed in research and design laboratories. These challenging effects of band impingement may directly compromise local resistance related to subgingival pathogens in susceptible patients and result in damage to both interproximal gingival tissues and alveolar crestal bone in a manner similar to that produced by faulty crown margins. Periodontal support might also be damaged during tooth intrusion where patients have active periodontitis or gingival infection significant enough to convert to periodontal disease.

The etiology of periodontal problems may not simply rely on exaggerated host immunologic reactions. Mattingly and coworkers [18] and others [19.20.21] reflect the view that long-term fixed appliances can contribute to unfortunate but predictable qualitative alterations in the subgingival bacterial biofilms that become progressively periodontopathic with time.

On a practical level it seems that an absence of bleeding on probing is a better forecasting parameter of health than bleeding on probing is a predictor of progressive disease. In other words, an absence of bleeding on probing, despite the pocket depth can justifiably be used as a test of “healthy gums.” On the other hand, while bleeding on probing is certainly an indication of infection of the gingivae, it is one of many risk factors associated with progressive bone loss due to periodontitis. However, the test is not spontaneous bleeding or even bleeding on brushing and flossing. That elicits only superficial disease, one that contributes significantly to caries and marginal decalcification. The best test is “bleeding on probing” elicited by stroking the sulci with a flexible plastic periodontal probe at a comfortable range of force between 10 and 20 g. Those orthodontic patients who present with persistent bleeding on such probing should be notified that they are “at risk” and that prudence dictates a more intensive regimen of periodontal therapy than those who present with little or no bleeding on probing. Since bleeding swollen gingiva is ubiquitous in the orthodontic population, universal caution should be employed and supportive periodontal care recommended routinely as an integral part of orthodontic therapy. Studies have pointed out the importance of a full-mouth examination, six sites per tooth, for a comprehensive description of periodontal status in orthodontic patients [22.23].

### **3.3. 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 [24.25.26]. Moreover, the orthodontic treatment allows that the stable periodontal status is maintained [27.28.29.30]

Although there is no clear correlation between malocclusion and periodontal disease or between the effects of orthodontic treatments on periodontal improvement the literature describes clear interaction between Orthodontics and Periodontics [9].

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 osseointegrated 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 [9].

## **4. Combined periodontal/orthodontic treatment**

### **4.1. Periodontal treatment schedule**

When planning orthodontic treatment in adults with a history of periodontal disease, it is suggested to allow 2–6 months from the end of periodontal therapy until bracket placement, for periodontal tissue remodelling, restoration of health and evaluation of patient's compliance. The patient should practise sound oral hygiene and fully understand the potential risks in case of non-compliance [8]. It should be kept in mind that the critical pocket depth for maintaining periodontal health with ordinary oral hygiene is 5–6 mm [31].

During orthodontic treatment, professional cleaning and examination of periodontal tissues should be performed routinely [8]. The specific interval varies for each patient (few weeks to 6 months), and it should be determined considering the analysis of risk factors for periodontal disease and the planned tooth movements. Thorough tooth cleaning and scaling is suggested at short intervals when intrusion and new attachment is attempted [32]. If the patient fails to maintain high level of oral hygiene, orthodontic treatment should be interrupted.

Elective periodontal treatment should be implemented during the final stages of orthodontic treatment or even later, when the final position of hard and soft tissues can be safely determined. The decision is individualized depending on the clinical characteristics of the case and the comprehensive treatment plan [33,34,35].

After the end of active orthodontic treatment and appliance removal, the patient should receive renewed oral hygiene instructions for reducing the risk of recession, because plaque removal and tooth cleaning will be more easily performed. Also, patients should be introduced to a programme of regular follow-up visits to the periodontist and the orthodontist. The timing between follow-up visits is prescribed by the team according to the severity of the patient's pre-treatment condition and the prognosis of the post-treatment condition.

## 4.2. Treatment phases

### 4.2.1. Preorthodontic phase

Preorthodontically, the emphasis is on reducing marginal inflammation, augmenting the soft tissue volume in patients with critical mucogingival findings, and improving hygiene conditions through caries therapy and temporary restorations.

The control of periodontal infection by oral hygiene instruction, professional plaque removal and root planing is a fundamental prerequisite for subsequent orthodontic therapy. Many studies have shown that teeth with a reduced but healthy periodontium can be moved without further attachment loss. On the other hand inflammatory periodontal destruction is accelerated by plaque-infected teeth with destroyed connective tissue attachment.

If periodontal regeneration is indicated, a surgical approach is inevitable. Resective bone surgery during flap surgery is contraindicated because orthodontically induced remodeling processes may have a positive influence on osseous topography. Orthodontic treatment can be started 4–6 weeks after the regenerative periodontal therapy; the interaction of progressing regenerative wound healing and orthodontic tissue remodeling may result in additional attachment gain [2].

### 4.2.2. Orthodontic phase

The orthodontic therapy is determined by two key factors:

- Findings-oriented biomechanics, calculation of active and reactive forces as well as moments as far as possible
- Continuous monitoring of periodontal health. Thorough planning of biomechanics reduces the risk of root resorptions as well as of bone and gingival dehiscences.

A further loss of bone support or attachment induced by uncontrolled force systems should be avoided in all events – especially in patients with periodontally affected teeth.

Maintenance of periodontal health requires meticulous plaque removal in all hygiene-critical areas: bracket periphery, and interproximal and gingival tooth surfaces. If uncontrollable aggravation of the periodontal destruction occurs or if the patient's oral hygiene deteriorates, orthodontic therapy has to be stopped to ensure a reasonable risk/benefit ratio [2].

#### 4.2.3. Postorthodontic phase

The postorthodontic retention phase should last at least six months to permit complete mineralization of osteoid tissues. Only then can the periodontal status be re-evaluated and a decision made on definitive prosthetic measures and the individual retention strategy. For many reasons postorthodontic stability requires semi-permanent or permanent retention:

- to prevent the risk of relapse
- to offset any imbalance of soft tissue/reduced bone support
- to eliminate secondary occlusal trauma
- to improve masticatory comfort in the presence of increased tooth mobility.

Fixed lingual retainers, passive plates or acrylic foils serve for semi-permanent stabilization, while intracoronal titanium pins are suitable for permanent retention [2].

## 5. Aspects in periodontic-orthodontic interrelationships

Generally, the main reasons routinely cited to justify the provision of orthodontic treatment are improvement of facial and dental aesthetics and of dental health and function. However, association between malocclusions and periodontal condition is still controversial.

Ngom and co-workers [4] found significant correlations between malocclusions and periodontal condition and suggested that malocclusions are risk markers for periodontal diseases. However, a real inference about a cause/effect relationship between malocclusions and periodontal condition in this study was not possible.

A review of the literature conducted by Van Gastel [5] showed contradictory findings on the impact of malocclusion and orthodontic appliances on periodontal health, since only a few studies reported attachment loss during orthodontic treatment. It has been suggested that this contradiction may be partly due to the selection of materials and differences in the research methods employed. However, our previous studies showed that orthodontic treatment in general does not have any negative effects on the periodontal tissues when a high level of oral hygiene is maintained [6,36].

Actually, between the year 1964 and 2007, sufficient studies had been conducted in terms of orthodontic treatment and possible related periodontal changes. Thus, it sounds plausible to extract evidence-based conclusions from those studies by means of systematic reviews.

In 2008, Bollen [36] conducted two systematic reviews to address the following questions: does a malocclusion affect periodontal health, and does orthodontic treatment affect periodontal health? The first review found a correlation between the presence of a malocclusion and periodontal disease. Subjects with greater malocclusion have more severe periodontal disease. The second review identified an absence of reliable evidence on the effects of orthodontic treatment on periodontal health. The existing low-quality evidence suggests that orthodontic therapy results in small detrimental effects to the periodontium. It has been suggested that the results of both reviews do not warrant recommendation for orthodontic treatment to prevent future periodontal problems, except for specific unusual malocclusions.

In 2010, Van Gastel and co-workers showed in his study [37] that placement of fixed orthodontic appliances has an influence both on microbial and clinical periodontal parameters, which were only partly normalized, 3 months following the removal of the appliances.

On the other side, it seems that there still are studies that give the orthodontic treatment positive points regarding periodontal health. Gray and McIntyre [38] conducted a systematic literature review to determine the effectiveness of orthodontic oral health promotion (OHP) upon gingival health, and it has been found that an OHP program for patients undergoing fixed appliance orthodontic treatment produces a short-term reduction (up to 5 months) in plaque and improvement in gingival health.

The results of Gomes and co-workers [39] indicate that use of orthodontics appliances is not necessarily related to a worsening of periodontal conditions. The results of this study reinforce the importance of susceptibility to periodontal disease independent of a well-known retentive plaque factor, i.e. orthodontic appliances and/or bands.

The existing evidence, in general, does not seem to support the claim that orthodontic therapy results in overall improvement in periodontal health.

## 6. Contribution of orthodontics to periodontal therapy

Orthodontics can serve as an adjunct to periodontal treatment procedures to improve oral health in a number of situations. Pathological tooth migration is one of the few evident signs of periodontitis that affects dentofacial esthetics. This phenomenon is more commonly seen in the anterior dentition due to lack of stable occlusal and sagittal contacts with the opposing teeth [39,40].

Achieving an esthetically acceptable result in such cases may require various orthodontic tooth movements like intrusion, rotation, and uprighting. This can also help control periodontal breakdown and restore good oral function [41].

Tulloch [42] is of the opinion that fixed appliance therapy is more preferable if orthodontic tooth movement is desired in a patient suffering from periodontitis. Fixed appliance allows easy splinting of teeth to achieve stable anchorage. He also highlights the importance of reducing the force magnitude and applying counteracting moments to reduce the stress on periodontal ligament fibres.

Lijian [24] has enlisted the various precautions to be taken when attempting tooth movement in height-reduced periodontium, which includes achieving stable anchorage and long-term periodontal maintenance care.

Deepa [43] reported the use of orthodontic soft aligners in repositioning a periodontally involved tooth. Light and intermittent forces generated by the soft aligner allow regeneration of tissue during tooth movement. Along with periodontal procedures, orthodontically assisted occlusal improvement may be required in treatment of patients with severely attrited lower anterior teeth.

Patient's compliance, motivation, and oral hygiene maintenance will help determine the best time to start adjunctive orthodontic treatment. It is suggested that tooth movement can be undertaken 6 months after completion of active periodontal treatment if there is sufficient evidence of complete resolution of inflammation [44].

Sanders [45] has recommended a three-step comprehensive protocol to be followed before, during, and after adjunctive orthodontic therapy. In patients diagnosed with vertical bony defects, adjunctive orthodontic procedures can help improve the condition. The authors reported improvement in alveolar bone defects, gingival esthetics, and the crown-root ratio in patients with one-or two-wall isolated infrabony defects with a combination of tooth extrusion and periodontal treatment. Orthodontic intrusion has also been shown to improve periodontal condition [46]. However, elimination of pockets was undertaken prior to intrusion in order to prevent apical displacement of plaque [47].

Orthodontic treatment could improve adjacent tooth position before implant placement or tooth replacement. This is especially true for the patient who has been missing teeth for several years and had drifting and tipping of the adjacent dentition

## **7. Contribution of periodontics to orthodontic therapy**

On many occasions, a stable and esthetically acceptable outcome cannot be achieved with orthodontics without adjunctive periodontal procedures. For instance, a high labial frenum attachment is considered to be a causative factor of midline diastema. Frenectomy is recommended in such cases as the fibres are thought to prevent the mesial migration of the central incisors. However, the timing of periodontal intervention has been a topic of much debate [37].

According to Vanarsdall, [49] surgical removal of a maxillary labial frenum should be delayed until after orthodontic treatment unless the tissue prevents space closure or becomes painful and traumatized.

Forced eruption of a labially or palatally impacted tooth is now a common orthodontic treatment procedure. Careful exposure of the impacted tooth while preserving keratinized tissue requires the expertise of a periodontist. Preservation of keratinized tissue is important to prevent loss of attachment. The preferred surgical procedure is primarily an apically or laterally positioned pedicle graft [50].

Retention of orthodontically achieved tooth rotation is a problem that has always plagued the orthodontist. Circumferential supracrestal fiberotomy (CSF) is a procedure that is frequently used to enhance post-treatment stability [50]. Edwards [51] concluded from his long-term prospective study that CSF is more successful in preventing relapse in the maxillary arch. According to him, CSF does not affect the periodontium adversely.

Mucogingival surgeries may be needed during the course of orthodontic treatment to maintain sufficient width of attached gingival [52]. Also, crown lengthening procedures can facilitate easy placement of orthodontic attachments on teeth with short clinical crowns. This procedure

can also be used for smile designing [53]. Alveolar ridge augmentation and placements of dental implants [54] are the other adjunctive periodontal treatment procedures undertaken to facilitate achievement of orthodontic treatment goals.

Panwar *et al.* [55] in 2010 presented a case report on combined periodontal and orthodontic treatment of pathologic migration of anterior teeth. Comprehensive orthodontics was initiated with pre-adjusted edgewise appliances using very light force, which resulted in optimal biological response. Since there was trauma from lower anterior teeth, anterior bite plane allowed posterior eruption of teeth, which resulted in the opening of the bite. The periodontal health improved the moment trauma was relieved. Periodontal treatment and the patient's co-operation in oral hygiene were also continued as supportive therapy.

Michael *et al.* in 2009 provided the treatment options for the significant dental midline diastema. After the required prosthetic intervention, periodontal tissues were altered by gingivoplasty and crown lengthening and provided optimal result with favorable esthetic, functional, and biologic consequences [56].

## 8. Case report

### 8.1. Case n°1



**Figure 1.** A patient who consults for gingival recession at the 24



**Figure 2.** Orthodontic treatment has been used to correct the malocclusion and to correct the rotation of the 24. A gingival grafting was performed to cover the recession

### 8.2. Case n°2



Figure 3. A patient who consults for malpositions and dental extrusions



Figure 4. Orthodontic treatment was aimed at correcting dental malposition and regain proper alignment will facilitate the oral hygiene.

### 8.3. Case n°3



Figure 5. A patient with dental malposition and higher gingival recession secondary to periodontal disease



Figure 6. Orthodontic treatment was able to obtain dental and periodontal balance while maintaining good oral hygiene.

#### 8.4. Case n°4



**Figure 7.** Clinical examination in this patient showed defective prostheses with poor periodontal status.



**Figure 8.** Orthodontic treatment was performed to correct the malocclusion. The patient also received a prosthetic rehabilitation.

### 9. Conclusion

Harmonious cooperation of the general dentist, the periodontist and the orthodontist offers great possibilities for the treatment of combined orthodontic–periodontal problems. Undoubtedly, application of oral hygiene measures is difficult during orthodontic treatment. Orthodontic treatment along with patient’s compliance and absence of periodontal inflammation can provide satisfactory results without causing irreversible damage to periodontal tissues. Furthermore, orthodontic treatment can expand the possibilities of periodontal therapy in certain patients, contributing to better control of microbiota, reducing the potentially hazardous forces applied to teeth and finally improving the overall prognosis. Participation of the periodontist is also essential, either in management of orthodontic–periodontal problems or in specific interventions aiming to prevent orthodontic treatment’s relapse.

## Author details

Mourad Sebbar<sup>1\*</sup>, Zouhair Abidine<sup>1</sup>, Narjisse Laslami<sup>2</sup> and Zakaria Bentahar<sup>2</sup>

\*Address all correspondence to: [mouradsebbar@hotmail.com](mailto:mouradsebbar@hotmail.com)

1 Hospital Moulay Abdellah, Mohammedia, Morocco

2 Department of orthodontics, Faculty of dentistry, Casablanca, Morocco

## References

- [1] Gkantidis N, Christou P, Topouzelis N. The orthodontic–periodontic interrelationship in integrated treatment challenges: a systematic review. *J Oral Rehabilitation* 2010;37:377-390.
- [2] Diedrich P, Fritz U, Kinzinger G. Interrelationship between Periodontics and Adult Orthodontics *Perio* 2004;1(3): 143-149.
- [3] Dannan A. An update on periodontic-orthodontic interrelationships. *J Indian Soc Periodontol* 2010;14: 66-71.
- [4] Ngom PI, Benoist HM, Thiam F, Diagne F, Diallo PD. Influence of orthodontic anomalies on periodontal condition. *Odontostomatol Trop* 2007;301:9-16.
- [5] Van Gastel J, Quirynen M, Teughels W, Carels C. The relationships between malocclusion, fixed orthodontic appliances and periodontal disease: A review of the literature. *Aust Orthod J* 2007;23:121-9.
- [6] Dannan A, Darwish MA, Sawan MN. Effect of orthodontic tooth movements on the periodontal tissues. *Damascus Univ Journal for Health Sciences [Master Thesis]* 2005;21:306-7.
- [7] Dannan A, Darwish MA, Sawan MN. How do the periodontal tissues react during the orthodontic alignment and leveling phase? *Virtual J Orthod* 2008;8:1-7.
- [8] Sanders NL. Evidence-based care in orthodontics and periodontics: a review of the literature. *J Am Dent Assoc.* 1999;130(4):521-7.
- [9] Del Santo M. Periodontium and Orthodontic Implications: Clinical Applications. *Int J Stomatol Res* 2012, 1(3): 17-23.
- [10] Jackson CL. Comparison between electric toothbrushing and manual toothbrushing, with and without oral irrigation, for oral hygiene of orthodontic patients. *Am J Orthod Dentofacial Orthop.* 1991;99(1):15-20.

- [11] Wilcoxon DB, Ackerman RJ, Jr., Killoy WJ, Love JW, Sakumura JS, Tira DE. The effectiveness of a counterrotational-action power toothbrush on plaque control in orthodontic patients. *Am J Orthod Dentofacial Orthop.* 1991;99(1):7-14.
- [12] Brightman LJ, Terezhalmay GT, Greenwell H, Jacobs M, Enlow DH. The effects of a 0.12% chlorhexidine gluconate mouthrinse on orthodontic patients aged 11 through 17 with established gingivitis. *Am J Orthod Dentofacial Orthop.* 1991;100(4):324-9.
- [13] Pontier JP, Pine C, Jackson DL, DiDonato AK, Close J, Moore PA. Efficacy of a pre-brushing rinse for orthodontic patients. *Clin Prev Dent.* 1990;12(3):12-7.
- [14] Denes J, Gabris K. Results of a 3-year oral hygiene programme, including amine fluoride products, in patients treated with fixed orthodontic appliances. *Eur J Orthod.* 1991;13(2):129-33.
- [15] Lindhe J. *Textbook of clinical periodontology.* 2nd ed. Copenhagen: Munksgaard; 1989.
- [16] Proffit WR, Fields HW. *Contemporary orthodontics.* 2nd ed. St Louis: CV Mosby; 1993.
- [17] Reitan K. Biomechanical principles and reactions. In: Graber X, Swain BF, editors. *Current orthodontic concepts and techniques.* St Louis: CV Mosby; 1985. p. 101-92.
- [18] Mattingly JA, Sauer GJ, Yancey JM, Arnold RR. Enhancement of *Streptococcus mutans* colonization by direct bonded orthodontic appliances. *J Dent Res* 1983;62:1209-11.
- [19] Paolantonio M, Festa F, di Placido G, D'Attilio M, Catamo G, Piccolomini R. Site-specific subgingival colonization by *Actinobacillus actinomycetemcomitans* in orthodontic patients. *Am J Orthod Dentofacial Orthop* 1999;115:423-8.
- [20] Sallum A, *et al.* Clinical and microbiologic changes after removal of orthodontic appliances. *Am J Orthod Dentofacial Orthop* 2004;126:363-6.
- [21] Perinetti G, Paolantonio M, Serra E, D'Archivio D, D'Ercole S, Festa F, *et al.* Longitudinal monitoring of subgingival colonization by *Actinobacillus actinomycetemcomitans*, and crevicular alkaline phosphatase and aspartate aminotransferase activities around orthodontically treated teeth. *J Clin Periodontol* 2004;31:60-7.
- [22] Lijian L. Periodontic-orthodontic interactions—rationale, sequence and clinical implications. *Hong Kong Dent J* 2007;4:60-4.
- [23] Lang NP, Loe H. The relationship between the width of keratinized gingiva and gingival health. *J Periodontol* 1972;43:623-7.
- [24] Elliasson LA, Hugoson A, Kurol J, Siwe H. The effects of orthodontic treatment on periodontal tissues in patients with reduced periodontal support. *Eur J Orthod* 1982;4:1-9.

- [25] Boyd RL, Leggot PJ, Quinn RS, Eakle WS, Chambers DW. Periodontal implications of orthodontic treatment in adults with reduced or normal periodontal tissues versus those of adolescents. *Am J Orthod Dentofac Orthop* 1989;96:191-8.
- [26] Ong M A Wang HL. Periodontic and orthodontic treatment in adults. *Am J Orthod Dentofac Orthop* 2002;122:420-8.
- [27] Brown S The effect of orthodontic therapy on certain types of periodontal defects (I). Clinical findings. *J Periodontol* 1973;44:742-56.
- [28] Ingber JS. Forced eruption. Part I. A method of treating isolated one and two wall infrabony osseous defects – rationale and case report. *J Periodontol* 1974;45:199-206.
- [29] Ingber JS. Forced eruption. Part II. A method of treating nonrestorable teeth – periodontal and restorative considerations. *J Periodontol* 1976;47:203-16.
- [30] Kraal JH, Digiancinto JJ, Dail RA, Lemmerman K, Peden JW. Periodontal conditions in patients after molar uprighting. *J Prosth Dent* 1980;43:156-62.
- [31] Socransky SS, Haffajee AD. The nature of periodontal diseases. *Ann Periodontol*. 1997;2:3–10.
- [32] Melsen B, Agerbaek N, Markenstam G. Intrusion of incisors in adult patients with marginal bone loss. *Am J Orthod Dentofacial Orthop*. 1989;96:232–241.
- [33] Spear FM, Kokich VG, Mathews DP. Interdisciplinary man-agement of anterior dental esthetics. *J Am Dent Assoc* 2006;137:160–169.
- [34] Konikoff BM, Johnson DC, Schenkein HA, Kwatra N, Waldrop TC. Clinical crown length of the maxillary anterior teeth preorthodontics and postorthodontics. *J Periodontol*. 2007;78:645–653.
- [35] Theytaz GA, Kiliaridis S. Gingival and dentofacial changes in adolescents and adults 2 to 10 years after orthodontic treatment. *J Clin Periodontol*. 2008;35:825–830.
- [36] Bollen AM. Effects of malocclusions and orthodontics on periodontal health: Evidence from a systematic review. *J Dent Educ* 2008;72:912-8.
- [37] Van Gastel J, Quirynen M, Teughels W, Coucke W, Carels C. Longitudinal changes in microbiology and clinical periodontal parameters after removal of fixed orthodontic appliances. *Eur J Orthod* 2011;33:15-21.
- [38] Gray D, McIntyre G. Does oral health promotion influence the oral hygiene and gingival health of patients undergoing fixed appliance orthodontic treatment? A systematic literature review. *J Orthod* 2008;35:262-9.
- [39] Gomes SC, Varela CC, da Veiga SL, Rösing CK, Oppermann RV. Periodontal conditions in subjects following orthodontic therapy. A preliminary study. *Eur J Orthod*. 2007;29(5):477-81.
- [40] Vinod K, Reddy YG, Reddy VP, Nandan H, Sharma M. Orthodontic-periodontics interdisciplinary approach. *J Indian Soc Periodontol*. 2012;16(1):11-5.

- [41] Zachrisson BU. Orthodontics and periodontics. In: Lindhe J, Karring T, Lang NP, editors. *Clinical periodontology and implant dentistry*. 4th ed. Oxford: Blackwell Munksgaard; 2003:744-80.
- [42] Tulloch JF. Adjunctive treatment for adults. In: Proffit WR, Fields J r HW, editors. *Contemporary orthodontics*. 3rd ed. St. Louis: Mosby; 2000:616-43.
- [43] Deepa D, Mehta DS, Puri VK, Shetty S. Combined periodontic-orthodontic-endodontic interdisciplinary approach in the treatment of periodontally compromised tooth. *J Indian Soc Periodontol* 2010;14:139-43.
- [44] Padmanabhan S, Reddy VL. Inter-disciplinary management of a patient with severely attrited teeth. *J Indian Soc Periodontol* 2010;14:190-4.
- [45] Sanders NL. Evidence-based care in orthodontics and periodontics: A review of the literature. *J Am Dent Assoc* 1999;130:521-7.
- [46] Lino S, Taira K, Machigashira M, Miyawaki S. Isolated vertical infrabony defects treated by orthodontic tooth extrusion. *Angle Orthod* 2008;78:728-36.
- [47] Sam K, Rabie AB, King NM. Orthodontic intrusion of periodontally involved teeth. *J Clin Orthod* 2001;35:325-30.
- [48] Melsen B. Tissue reaction following application of extrusive and intrusive forces to teeth in adult monkeys. *Am J Orthod* 1986;89:469-75.
- [49] Vanarsdall RE. Periodontal/orthodontic interrelationships. In: Graber TM, Vanarsdall RE, editors. *Orthodontics-current principles and technique*. 3rd ed. St. Louis: Mosby; 2000:801-38.
- [50] Vanarsdall RL, Corn H. Soft-tissue management of labially positioned unerupted teeth. *Am J Orthod* 1977;72:53-64.
- [51] Edwards JG. A surgical procedure to eliminate rotational relapse. *Am J Orthod* 1970;57:35-46.
- [52] Edwards JG. A long-term prospective evaluation of the circumferential supracrestal-fibrotomy in alleviating orthodontic relapse. *Am J Orthod Dentofacial Orthop* 1988;93:380-7.
- [53] Kokich VG. Esthetics: The orthodontic-periodontic restorative connection. *Semin Orthod* 1996;2:21-30.
- [54] Huang LH, Shotwell JL, Wang HL. Dental implants for orthodonticanchorage. *Am J Orthod Dentofacial Orthop* 2005;127:713-22.
- [55] Panwar M, Jayan B. Combined periodontal and orthodontic treatment of pathologic migration of anterior teeth. *MJAFI* 2010;66:67-9.
- [56] Michael R. Treatment options for the significant dental midline diastema inside dentistry 2009. <http://www.dentalaegis.com/id/2009/05/clinical-treatment-options-treatment-optionsfor-the-significant-dental-midline-diaastema>.