CLINICAL EFFECTS OF ORTHODONTIC TREATMENT ON PERIODONTAL STATUS. REVIEW.

Ioana Sioustis¹, Maria-Alexandra Martu²*, Ionut Luchian¹, Cornelia Teodorescu¹, Diana-Cristala Kappenberg-Nitescu¹, Alexandru Iovan³, Silvia Martu¹.

¹”Grigore T. Popa” University of Medicine and Pharmacy, Iaşi, Romania, Faculty of Dental Medicine, Department of Periodontology;
²”Grigore T. Popa” University of Medicine and Pharmacy, Iaşi, Romania, Faculty of Dental Medicine, Department of Orthodonty;
³Dentist, Privat Practice, Iasi

Corresponding author: Martu Maria-Alexandra *
E-mail: alexandra_martu@yahoo.com

Abstract
The purpose of this review is to describe the most frequently observed changes of the periodontium caused by orthodontic treatment, in order to facilitate the collaboration and communication of the specialists. This review also aims to explore the literature to select specific critical concepts and multidisciplinary connections and to highlight the importance of specialty cooperation. An electronic search of the database was performed using the PubMed database. Modifications of soft and hard periodontal tissues during orthodontic treatment and maintenance are discussed to provide a more comprehensive picture of the possible interactions between these two interrelated disciplines.

Keywords: orthodontic treatment, periodontal status, periodontal disease

1. Introduction
Due to the increased aesthetic demands of the population in recent years, orthodontic treatment is increasingly adopted among the population, especially the adult population. Since adult orthodontic patients may also have prosthetic and periodontal restorative needs, the interaction between different specialties becomes even more important. On the other hand, many patients’ with periodontal disease may experience pathological dental migrations, traumatogenic occlusion or other prosthetic deficiencies in which orthodontics may be an important part of their treatment.

Both periodontists and orthodontists must understand the individual therapeutic endpoints and collaborate in clinical practice to provide the best treatment possible to their patients. An electronic database search was performed using the PubMed database and reviews, clinical trials, animal studies, and comparative studies were selected to describe the observations on changes in soft and hard periodontal tissues during movement orthodontics of teeth (OTM) in orthodontic and periodontal literature.

2. Changes in soft tissue
Orthodontic treatment can be implemented to improve dental aesthetics not only by correcting the position of
dental units but also by creating conditions for optimizing gingival and periodontal health. Adult patients previously affected by periodontal disease often present with inelegant 'black triangles' because of the low height of the interdental papillae.

Through orthodontics it is possible to correct the position of the teeth and improve the aesthetics of the soft tissues. It has been suggested that by closing the orthodontic treatment space the interproximal alveolar bone elevation topography could change and improve the position of the interdental papilla [1], although black triangles may also appear as a consequence of the teeth alignment after the treatment of dental crowding in some cases of particular dental forms favoring the lowering of the gingival level.

In these cases, the morphological augmentation through the coronary resurfacing of the teeth can help to move more apical the point of contact during the orthodontic approach of the teeth. This could contribute to optimal aesthetic results [2].

During the OTM, some adverse effects on soft periodontal tissue may be observed. The most common changes in soft tissue are gingival overgrowth (GO), gingival recession (GI), and gingival invagination (GI), which occur frequently in cases of orthodontic extraction.

Gingival overgrowth is a very common condition in the orthodontic population that is characterized by gingival hypertrophy that can lead to the appearance of false pocket with or without loss of attachment. When involved, the previous region may have an impact on the quality of life related to oral health [3]. Traditionally, GO was considered an inflammatory reaction following the accumulation of bacterial plaque [4].

Other factors, such as chemical irritation produced by materials used for bonding brackets or other orthodontic devices, the mechanical irritation produced by abrasive tapes used in the interproximal reduction and food impaction and food persistence between orthodontic devices and gingival tissue have been suggested to explain the pathogenesis of GO [5]. Şurlin et al. [6] evaluated orthodontic patients with good dental hygiene who presented GO without clinical signs of gingival inflammation.

These patients exhibited high levels of metalloproteinase-8 (MMP-8) and metalloproteinase-9 (MMP-9) in gingival crevicular fluid (GCF). It was believed that during orthodontic treatment, mechanical stress appears to be one of the key factors leading to increased production of MMP-9 and onset of GO.

Some authors also assessed the possible role of an allergic reaction to nickel in orthodontic appliances or accessories used in the treatment. In vitro and in vivo studies suggest that liberated nickel ions can cause an allergic reaction dependent on exposure time, characterized by increased proliferation of keratinocytes and epithelial cells [7, 8].

Therefore, making a rigorous history of assessing history of metal allergies prior to orthodontic treatment is imperative. In addition, careful monitoring throughout therapy is necessary to take into account changes over time as these have been associated with an increased frequency of GO [9-11].
In the orthodontic treatment, it may be necessary to extract the teeth, most often extracting the first or second premolar. After closing the orthodontic space of the extraction sites may result gingival invagination or the accumulation of gingival tissue [12].

The frequency of gingival invagination is reported to be elevated and can be observed more often in the lower jaw [13-15]. GI can influence proper plaque control due to its location, possibly contributing to gingival and periodontal disease [13, 16]. There is a correlation between the gingival fissure and the appearance of the OTM. Significantly more GIs were reported when there was a delay in space closure and orthodontic treatment was initiated late after teeth extraction [14, 17].

Gingival growth may exhibit a high degree of variability, ranging from a superficial crease to severe defects, with complete penetration of the alveolar ridge (25% of all clefts) [14]. To prevent GI formation during OTM in the post-treatment area, Guided Bone Regeneration (GBR) can be applied.

Both in the orthodontic and periodontal literature there is a thorough discussion about the gingival recession that can lead to unsatisfactory aesthetics, root sensitivity, increased cavity susceptibility, dental abrasion and difficulty in maintaining oral hygiene. OTM can promote GR formation or improve soft tissue condition [18-25]. Of the orthodontic patients, up to 10-12% experienced gingival recessions [18, 26].

One of the main reasons for the development of GR is considered to be a continuous mechanical trauma due to inadvertent and incorrect dental brushing [27, 28], but Matthews [29] and Rajapakse et al. [30] suggested that there is no clear evidence of the direct link between brushing and non-inflammatory GR. Several particular anatomical and morphological features have been suggested in GR formation. During OTM, bone dehiscences can occur when the roots move through the alveolar cortical bone [38-40].

This type of motion can cause dehiscence more often in patients with a thin alveolar process, increases thin vestibular or lingual bone, an excentric position of the teeth, enlarged jaw, large volumetric sinus and progressive loss of the alveolar bone [41]. It should be noted that if the tooth is moved inside the spongy alveolar bone, the risk of harmful side effects on marginal soft tissue is minimal [31,33].

The direction of orthodontic forces applied may also have an impact on soft tissues. Some studies have suggested that controlled proclination of mandibular incisors within the anatomical limits imposed by the symphysis thickness could be performed in orthodontic patients without the risk of periodontal damage if a good level of dental hygiene is assured [19, 26, 35, 36].

Recent studies have suggested that orthodontic proclination [37, 38] can be significantly associated with a reduction in the width of the keratinized tissue. These findings are supported by previous studies suggesting that vestibular teeth movement can reduce the thickness of vestibulo-labial
tissue and reduce the height of the free gingiva by facilitating GR.

On the other hand, the lingual dental movement may have the opposite effect [21, 31, 37], of course the existing gingival biotype must also be taken into account. A strong correlation was found between the thin biotype and the orthodontic proclination movement in terms of the GR depth and the keratinized tissue width. Unlike patients with a thick periodontal biotype, those with a thin biotype are considered to be at increased risk [37, 38].

The thin periodontal biotype and the amount of attached gingiva have been found to be significantly correlated with lingual bone crest thickness and alveolar crest. The thin periodontium shows low resistance to mechanical stress or inflammation and may correlate with the development of GR [20, 35, 37, 38].

Mucogingival surgery during orthodontic treatment aims to change the soft tissue characteristics locally in order to create more favorable conditions and increase resistance to mechanical stress. However, improved gingival features cannot guarantee the absence of gingival recession after OT, especially when a significant expansion of the dental arcade or vestibular proclination is performed, and a second surgery after the orthodontic treatment may be required.

To patients with a thin biotype should be performed grafting procedures before OTM to reduce the risk and extent of possible GR. So far, it is not clear which periodontal and biomechanical characteristics may predispose to GR and which would be the incidence of GR in each specific scenario.

A different scenario may occur if GR will appear during OTM. In these cases, soft tissue grafting is indicated and should be performed as soon as possible provided all the other parameters (gingival inflammation, trauma, etc.) are controlled. The goal is to treat the recession as long as the dimension is minimum as possible and to improve treatment prognosis. Orthodontic therapy should be carefully evaluated during this time to determine whether or not to stop the OTM until complete healing. Clearly, the chronology of GR is important, and we should better understand the implications of a GR that appears in the first third of orthodontic treatment compared to the one that appears near the final period of OTM.

When pre-existing GR is detected prior to orthodontic treatment, the impact of orthodontic treatment should be carefully evaluated. If the lingual teeth movement is planned, mucogingival surgery may not be necessary and even the OTM may improve or at least not worsen the recession. When necessary, the prognosis of mucogingival surgery can be improved after the tooth is moved lingually.

If the tooth is vestibular inclined, a mucogingival corrective procedure should be considered to avoid progression of the disease. OTM may be initiated after complete cure (3-4 months). At the end of orthodontic therapy, the site should be re-evaluated and a second intervention may be required in a limited number of cases.

3. Changes that occur in the bone
Mechanical force during OTM results in bone resorption and bone apposition, widely discussed both in orthodontic literature and periodontal literature. In the health state, during the OTM, all components of the periodontal attachment, including the bone structure, the periodontal ligament and the soft tissue components move along with the tooth. After periodontal treatment, mild, controlled orthodontic forces combined with good dental hygiene control may be sufficient to lead to teeth alignment when the periodontal support is diminished.

Several studies have suggested that OTM after surgical periodontal treatment may have an impact on bone defect morphology, reducing the depth of periodontal pockets and improving connective tissue healing. All positive changes in the support device were made only when a good control of dental hygiene was achieved.

Some authors have applied intrusive orthodontic forces and reported clinical and radiological improvements [42, 43]. It was also reported in the histological study by Melsen et al. [44] that new cement formation and new collagen attachment can be achieved through orthodontic intrusion in the presence of good dental hygiene. Polson et al. [40] further assessed attachment to such teeth and reported the presence of a long junctional epithelium between the bone and the root surface after teeth movement in and through the defect, suggesting that there is no regeneration at the support periodontal structures.

Therefore, it has been recommended to apply GTR techniques to treat infrabony deficiencies before orthodontic therapy in order to obtain regeneration instead of repair. The efficacy of periodontal regeneration in the treatment for the prognosis of regenerative treatment; however, a systematic review recently argued that clinical results of periodontal regeneration would be influenced by the patient's hygienic behavior and surgical approach more than tooth features and defect characteristics [47]. Araújo et al. [48] suggested that it is possible to move the sites of periodontal treatment initiation regimens after GTR, suggested that significant improvements in periodontal regeneration can be observed in defects treated with immediate application of orthodontic forces after surgery. Others demonstrated that the orthodontic treatment performed 1 year after GTR, when the hard and soft tissues were mature, did not cause any adverse effect on the results of periodontal regeneration [2].

4. Maintenance period

The importance of maintaining good hygiene in dental practice, especially in cases where orthodontics is combined with periodontal treatment, is known. For all patients undergoing orthodontic treatment with fixed devices it is difficult to maintain a good level of oral hygiene, as orthodontic constructions and accessories can prevent conventional brushing and conventional interdental use.

Deficient oral hygiene in orthodontic patients appears to be a key factor in the development of white spot
lesions, dental caries and gingival inflammation due to dental plaque accumulation [53, 54]. In the presence of insufficient dental hygiene, orthodontic treatment can lead to the supragingival and subgingival supragingival dental plaque, resulting in the formation of infrabony periodontal pockets [55].

The type of device (fixed or mobile), bracket material, collage technique (lingual or vestibular) and the type of retention device selected for orthodontic therapy can influence the patient's ability to maintain a good level of plaque control.

During OTM, halen, plaque index and gingival index increase and the first changes can be observed immediately after the collage [54, 56].

The bracket material seems to influence the quantity and location of the plaque. Stainless steel brackets seemed to cover significantly larger amounts of plaque than ceramic, sapphire and polycarbonate brackets. When ceramic brackets are used, most of the plaque accumulates on the occlusal and gingival surfaces, while plaque accumulates more on the mesial and distal surfaces when using stainless steel brackets. [57-59].

To reduce the risk of periodontal damage during and after the OTM, more attention should be paid to the characteristics of orthodontic devices during the planning of orthodontic therapy. It appears that the precise control of the magnitude of the force is the key element in order to avoid periodontal alteration [64,66,67] and there are studies that sustain and demonstrated this at the level of the lateral mandibular incisor [63].

The periodontal problems should not be hidden from the patients, they should be advised to improve their dental hygiene as often as possible, also periodontal treatment should be implemented because if the treatment is delayed serious periodontal issues could influence the result of the orthodontic treatment [68].

Periodontal status in orthodontically treated patients should be evaluated not only during treatment but also after the removal of the orthodontic appliances, but also during the period of contention. In pediatric patients under orthodontic treatment, plaque control should be closely monitored. Periodontal status is important in order to have and maintain good oral cavity health, the need for further studies is obvious in order to establish the chronology of application of orthodontic therapy, periodontal therapy and specifics.

**Conclusions**

1. Patient compliance, motivation and maintenance of oral hygiene are universally recognized as important factors in assessing the impact of the OTM on their periodontal status. These parameters are important for maintaining periodontal status after non-surgical and surgical periodontal therapy and should be continued later.

2. Taking into account the additional difficulties in daily hygiene for orthodontic patients during fixed device therapy, regular monitoring of adults with predisposition to periodontal disease during OTM is required.
3. Orthodontists should pay special attention to sanogenic dental education, highlighting the instructions for oral hygiene and periodontal care.

4. Regular periodontal checks and quality professional hygiene sessions are essential even after the completion of orthodontic therapy.

REFERENCES


