Chapter 6

Orthodontics and Periodontology: Multidisciplinary Treatment and Current Approaches

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Abstract

Orthodontics provides ideal tooth and jaw relations and has important biological effects on the periodontium. Periodontal health should be constantly considered throughout the orthodontic treatment process because changes in the periodontium also directly affect the success of orthodontic treatment.

This chapter will evaluate the effects of orthodontic treatment, different orthodontic movements, and mechanics on periodontal health and will be discussed separately. Also, the methods used to prevent relapse that may occur after orthodontic treatment and their effects on periodontal health will be discussed.

The common result of the studies indicates that orthodontic treatment planning in individuals with periodontal disease should be done carefully and by considering the systemic health of the patient. The success of orthodontic treatment is significantly increased if the above-mentioned points are taken into consideration.

Consequently, a multidisciplinary working environment should be established to reduce the negative effects of orthodontic treatment on the periodontium and to increase the success of treatment.

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Introduction

Microbiology studies pathological microorganisms, being one of the most important factors affecting human health since the beginning of life. While oral flora is home to a large number and variety of harmful and harmless microorganisms, oral microbiology examines harmful microorganisms in the oral environment.

Van Leeuwenhoek examined microorganisms in dental plaque using a simple microscope in the 17th century. This event is considered the beginning of oral microbiology (He & Shi, 2009). Robert Hooke, a contemporary of the same period, further improved this primitive microscope to make microorganisms more visible (Gest, 2005). Although the invention of the microscope goes back to the 17th century, an Indian community leader named 'Vardhmana Mahavira,' who lived in the period before Christ, suggested the existence of small microorganisms named 'Nigora' (Singh, 2009). Along with the invention of the microscope, there has been a rapid increase in the level of knowledge of humanity; the existence of microorganisms, the reality of which was controversial, has been proven, and the microbiology department has been established.

Oral microbiology has developed considerably in light of this cumulative knowledge and technological developments and has become an important branch of science that helps dentistry in the understanding, classification, and treatment of periodontal and systemic diseases (İşler, 2023).

It is believed that periodontal diseases have existed since the beginning of human history. Especially paleopathologists examining skulls from ancient times point to destructive periodontal diseases. A Sumerian tablet from 5000 BC explains that the Sumerian people suffered from periodontal diseases and applied herbal mixtures to the gums and massaged them for treatment (Brkić & Pavlić, 2017).

Hesy-Re, who lived in the 3rd Egyptian Dynasty in the 27th century BC, is the oldest person identified as a dentist (Brkić & Pavlić, 2017). A tablet in his tomb bears the phrase "the greatest of those who deal with teeth and the greatest of physicians". He is also known as the first person to define periodontal disease (Mitsis & Taramidis, 1995; Ziskind & Halioua, 2007).

During the Renaissance period, Italian anatomist and physician Bartolomeo Eustachi (1514-1574) described the periodontal ligament, deciduous and permanent teeth in his work 'Libellus de Dentibus' (Gold, 1985). He associated the reason for the increased tooth mobility in old age with the expansion of this periodontal ligament between the root surface of

the tooth and the underlying bone. He also recommended the removal of calculus and granulation tissue to tighten this loose junction (Dentino et al., 2013)

Pierre Fauchard (1678-1761), considered the father of dentistry, included some periodontal issues in his book 'Le Chirurgien Dentiste' (Maloney & Maloney, 2009). He introduced periodontal instruments of his own invention, such as a donkey's nose, a parrot's beak, and a Z-shaped hook, and described the methods of scaling using these instruments. He also proposed the method of fixing the moving tooth using gold wire (Maloney & Maloney, 2009).

In the 19th century, two German physicists, Robert Ficinus (1809-1852) and Adolph Witzel (1847-1906), attributed the bone loss in the alveolar bone with periodontal disease to the presence of bacteria. The development of microbiology at that time played a major role in this (Dentino et al., 2013; Newman et al., 2020).

1. What is Periodontology?

The structure that supports the tooth and connects to it with various components is called periodontium (Ten Cate, 1997). The department that analyzes the healthy and diseased conditions of these periodontal tissues (periodontal ligament, gingiva, alveolar bone, cementum) is called periodontology (Dentino et al., 2013) (Figure 1).

Periodontal disease is defined as a disease state that occurs when the integrity of this periodontal tissue is disrupted and is characterized by various clinical signs and symptoms (Baelum & Lopez, 2003; Tonetti & Mombelli, 1999; Van Der Velden, 2005).

John M. Riggs (1810-1885), known as the father of periodontology in the USA, believed that all stages of periodontal diseases were caused by calculus. Riggs achieved a success rate of over 90% by cleaning and curettage of calculus and providing oral hygiene education to his patients (Merritt, 1921).

Willoughby D. Miller (1853-1907) is known for his groundbreaking ideas on the aetiology of dental caries, such as the 'non-specific plaque hypothesis.' He also proposed the role of bacteria in alveolar pyorrhea and the potential of normal oral bacteria to cause periodontal disease (Theilade, 1986).

In the 20th century, alveolar pyorrhea was recognized as a treatable disease, and thus 'Periodontology' became a separate branch of dentistry (Dentino et al., 2013).

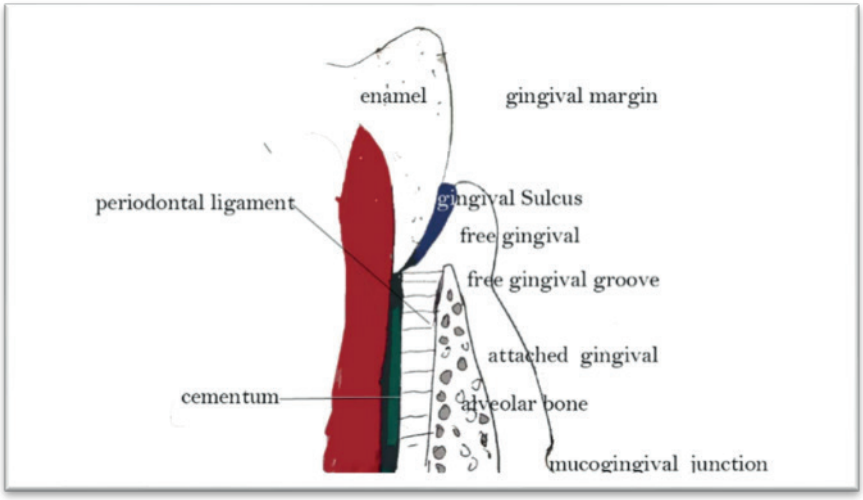

Figure 1: Anatomy of the periodontium (Madukwe, 2014).

Dental plaque is a biofilm layer formed by the settlement of a large number of microorganisms on the tooth surface in the oral cavity. It is among the main factors responsible for the formation of dental caries and periodontal disorders (Rosan & Lamont, 2000).

Dental plaque (biofilm), which is attached to tooth surfaces by means of an exopolysaccharide layer and for which streptococci are mainly responsible for its formation, is among the main causes of caries and dental diseases (Türkmen et al., 2016). Dental plaque is formed by pellicle formation, initial adhesion, maturation, and disintegration stages (Huang et al., 2011) (Figure 2).

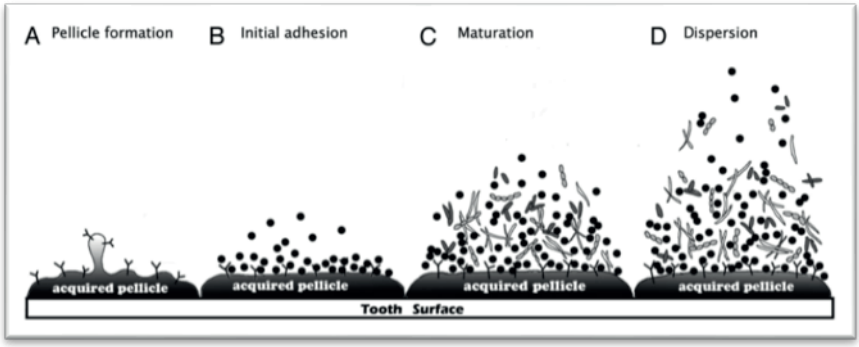

Figure 2: Stages of dental plaque formation (A, Pellicle formation. B, Initial adhesion. C, Maturation. D, Dispersion Stages of dental plaque formation)(Huang et al., 2011).

The most common form of periodontal disease caused by this structure called dental plaque is gingivitis. Bleeding that occurs when the gingival groove is probed slightly is one of the most important symptoms of gingivitis. Apart from this, swelling, redness, and an increase in gingival groove fluid are among the other symptoms (Mariotti, 1999).

Periodontology has become a separate branch of dentistry that has evolved with the cumulative accumulation of knowledge in the light of this information throughout history, protecting the health of the periodontium surrounding the teeth and playing an important role in the treatment of diseases.

2. The Interrelation Between Orthodontics and Periodontology

Today, the expectation from orthodontic treatment is not only limited to providing aesthetic improvement. It also aims to maintain a healthy periodontium and to eliminate orthodontic anomalies by creating a standardized tooth alignment. Achieving this goal is only possible by working in close cooperation with periodontology (Uludağ & Şar, 2014).

Ideal occlusion prevents food accumulation between the teeth and makes oral hygiene easier to achieve. This is achieved in the presence of adequate overjet and overbite with properly positioned and sized dental arches and incisal guidance of the anterior teeth. This ideal and uncrowded arch position has been found to be very favorable for oral hygiene (Kessler, 1976).

For orthodontic treatment to be successful, periodontal tissues should be under control before, during, and after treatment (Uludağ & Şar, 2014). This approach prevents the tooth movements that occur with orthodontic treatment from causing problems in periodontal tissues.

It is known that dental plaque formation increases significantly in patients under orthodontic treatment. This may cause undesirable changes in the periodontium and periodontal diseases in patients (Vinod et al., 2012). The bracket systems and/or orthodontic materials used may lead to more food accumulation and increased dental plaque formation.

While the need for periodontal treatment does not arise only in patients undergoing orthodontic treatment, the joint work of orthodontics and periodontology is required in the treatment of patients with periodontal disease. (Vinod et al., 2012). Periodontal problems that may complicate orthodontic treatment can be identified in advance, or periodontal problems that can be prevented with orthodontic treatment can be prevented with the multidisciplinary work of these two fields (Palomo et al., 2008).

Periodontal treatments other than major surgical operations such as pocket elimination should be performed before orthodontic treatment. Inflammation should be minimized as much as possible. This is because this inflammation can develop and progress much faster when combined with occlusal trauma and orthodontic movement than it can occur only in the case of chronic periodontal inflammation (Kessler, 1976).

3. Effects of Orthodontic Treatment on Periodontium

It is possible to obtain orthodontic tooth movement by applying controlled force with different types of orthodontic appliances (such as tipping, intrusion, extrusion, retraction, torque, and rotation). Resorption occurs on the side where the tooth applies pressure while moving, and apposition occurs in the opposite direction, that is, in the part where it causes stress. The simplest orthodontic movement is the tilting movement that occurs when the force is applied to one point of the tooth. The force applied to the crown causes it to rotate around the resistance center, which is approximately halfway to the root of the tooth (Proffit et al., 2020; Uludağ & Şar, 2014) (Figure 3).

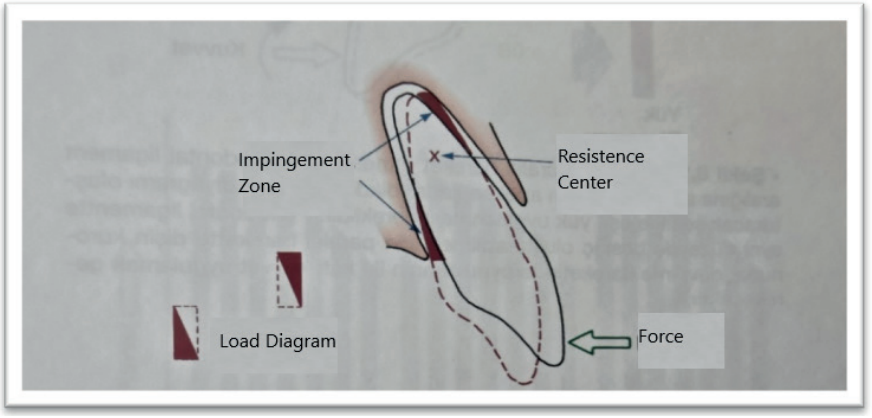

Figure 3: Impingement and stress zones in the alveolar bone due to orthodontic force (Proffit et al., 2020).

If the tilting movement occurs at the root of the tooth, it is called torque movement. If excessive torque force is applied to the orthodontic wire, resorptions and parallel fenestrations may occur on the buccal surface of the bone (Proffit et al., 2020; Uludağ & Şar, 2014) (Figure 4).

Figure 4: Mandibular anterior teeth with the apex overbuccalized to a large extent due to excessive and poor orthodontic forces (Proffit et al., 2020).

Intrinsic movement is the movement that occurs due to the expansion of the forces on the bone surface on a parallel line (Roberts et al., 1982). In order for a tooth to be able to move, the force diagram created from the periodontal ligament to the apex must pass through the resistance center of the tooth. It is required to apply approximately 2 times the force of the tilting movement to achieve this movement (Proffit et al., 2020) (Figure 5).

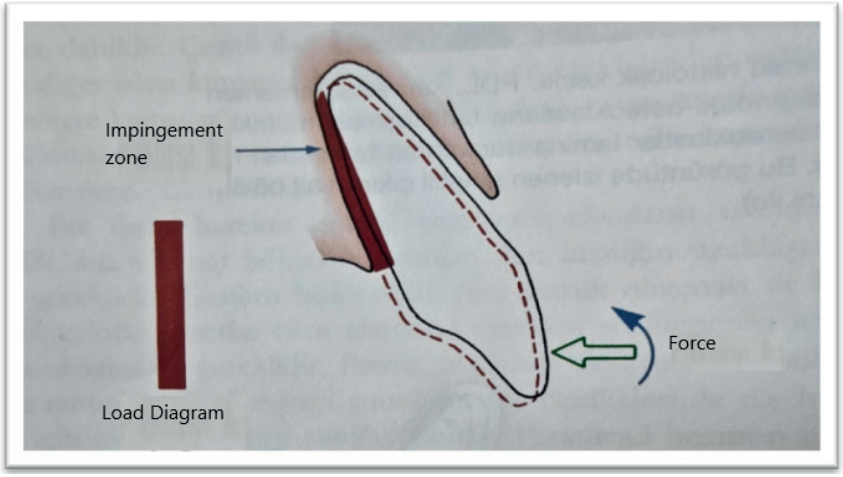

Figure 5: The impingement zone and force diagram formed in the reciprocating motion (Proffit et al., 2020).

Movement towards the pockets formed in the bone can provide improvement in the periodontium (Polson et al., 1984).

Rotation is one of the most difficult movements in orthodontics. The possibility of relapse is extremely high because during this movement, the previously mentioned zones of pressure and stress occur simultaneously on two different surfaces of the tooth. This can also cause fibrosis in the zones of bone apposition, especially in the marginal zone. This phenomenon may vary according to the different forces applied on different teeth (Uludağ & Şar, 2014).

The roots of malposed or rotated teeth may sometimes be very close to each other. This causes the presence of a thin interproximal septum in the parts where the roots are close to each other. Thus, periodontal tissues may be rapidly destroyed (Klassman & Zucker, 1969). Occasionally, the apex or part of the root of these rotated teeth may remain outside the bone. In such cases, bone defects called fenestration and dehiscence may occur, as seen in incorrectly applied torque movement. Correction of these rotated teeth and

placing them into the alveolar bone in such cases can correct bone defects such as fenestration and dehiscence (Kessler, 1976).

Extrusion is an orthodontic movement that shapes the tooth, alveolar bone and surrounding soft tissues when it is performed within the framework of ideal forces, while only creating a stress zone in the periodontal ligament (Uludağ & Şar, 2014). Since it also shapes the surrounding tissues, it can be used to eliminate the pocket depth of intraosseous defects (van Venrooy & Yukna, 1985). These positive effects of extrusion are maintained even if the tooth is later re-intruded (Kessler, 1976).

Among these orthodontic movements, the one that has the potential to cause the most periodontal problems is the intrusion movement due to the potential accumulation of forces at the root tip (Uludağ & Şar, 2014) (Figure 6).

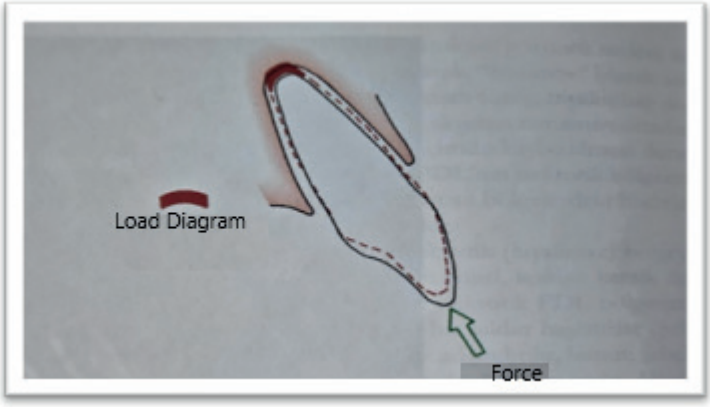

Figure 6: When a tooth is intruded, the force is concentrated on a single point apically, making it a potentially destructive movement (Proffit et al., 2020).

Intrusion of malposed maxillary centers does not always disrupt the relation of the gingival attachment to the tooth. However, if we bring the central teeth closer to the bone, we can turn suprabony pockets into infrabony pockets. This may require a surgical procedure in the future. Nevertheless, in order for this lesion, which turns into an infrabony pocket, to become inflammatory, inflammatory factors must occur again (Kessler, 1976).

4. Effects of treatment mechanics on the periodontium

Most patients with good oral hygiene develop gingivitis following orthodontic appliances, but attachment loss is rare. According to some

studies (ZACHRISSON & ALNÆS, 1974; ZACHRISSON & ALNAES, 1973), attachment loss has also been observed following fixed orthodontic appliances. Intraoral elements of fixed orthodontic treatment (such as brackets and band-fixed appliances) cause an increase in the rate of plaque formation (van Gastel et al., 2007).

Most researchers who have conducted systemic analyses of the effects of fixed appliances on the periodontium have found that fixed appliances cause a moderate change in periodontal status. No article reported a high level of associated change. It is generally accepted that gingivitis and plaque accumulation occur following orthodontic appliance placement (Cerroni et al., 2018).

Some researchers (Wu et al., 2020) conducted a meta-analysis study to compare the effects of fixed and removable orthodontic appliances on periodontal health. In this study, Plaque Index (PI), Gingival Index (GI), and Sulcus Probing Depth (SPD) values were analyzed, and it was concluded that the harmful effect of removable orthodontic appliances on periodontium was less compared to fixed orthodontic appliances. Removable orthodontic appliances are more advantageous in terms of oral hygiene and periodontal health because they can be removed and cleaned at any time.

The long-term effects of orthodontic treatment on periodontal health are contradictory (Cerroni et al., 2018). Some research results (Glans et al., 2003) revealed an improvement in periodontal health after orthodontic treatment, while others (Condò et al., 2013) showed an increased risk of mild to moderate periodontal disease.

5. Periodontal Changes and Relapse Prevention after Orthodontic Treatment

A certain amount of relapse is always seen in orthodontically treated rotated teeth. It has been stated that the biggest factor of relapse is the tendency of the stress in the transseptal and supracrestal fibers to release after treatment. Cutting the stretched fibers, i.e., 'Fiberotomy', is a technique that has been suggested to prevent relapse, and its success has been demonstrated by case studies (Ahrens et al., 1981).

More difficult than achieving the ideal occlusion is retention. Retention is an important part of orthodontics and its aim is to prevent relapse. Retention should be planned during the diagnostic phase of orthodontic treatment (Kharbanda, 2019). If necessary, overcorrection should be performed to increase the probability of success of retention.

In cases such as cleft lip and palate, treatment of excessive numbers of rotations and diastema closure, the susceptibility to relapse is higher, and fixed retention is necessary (Gill & Naini, 2012).

Fixed lingual retainers (Figure 7) are one of the most commonly used methods today, especially for the retention of mandibular anterior teeth. They provide longer and more reliable retention than traditional removable retainers because they are fixed and less disturbing to the patient (Üstdal et al., 2019).

Figure 7: Fixed lingual reinforcement appliance (Proffit et al., 2020).

The conclusions from a study (Quinzi et al., 2023) suggest that although removable retainers (Figure 8) are more advantageous in terms of periodontal health because they are easier to clean, their effectiveness varies from patient to patient because they require patient cooperation. The effect of fixed retainers on periodontal health was not statistically significant. For this reason, the physician should decide on the choice of retainer individually.

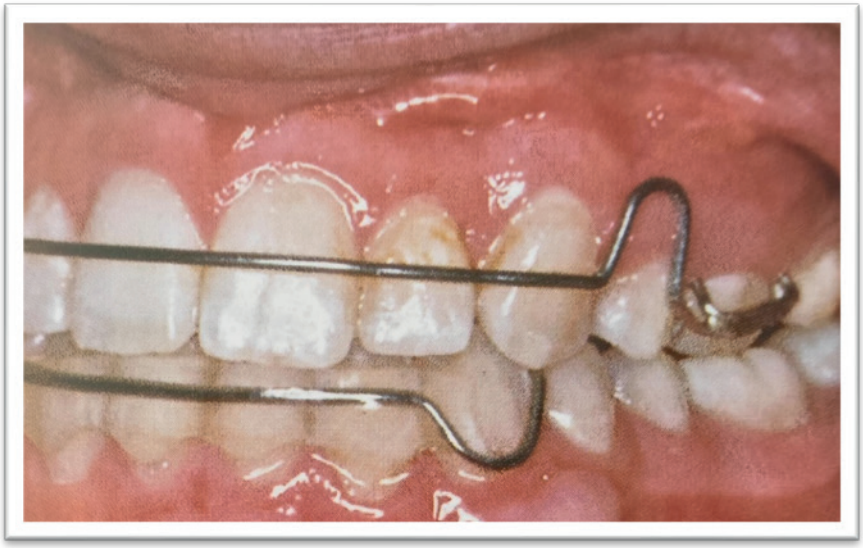

Figure 8: Movable reinforcement appliance (Proffit et al., 2020).

6. Orthodontic Treatment Approaches in Individuals with Periodontal Disease

If the patient's oral environment is healthy, the loss of attachments already present in the periodontium is not a contraindication for orthodontic treatment (van Gastel et al., 2007).

The effects of orthodontic treatment on the periosteum were analysed in detail in a study on patients with advanced periodontal problems. In these patients, elimination of deep periodontal pockets was not performed before starting orthodontic treatment, only phase-1 treatment was applied and oral hygiene training was given to the patient and phase-4 (maintenance phase) was started. The patient's gingiva, gingival pocket and alveolar bone were evaluated before phase-1 treatment, before and after orthodontic treatment and the values obtained were compared. It has been reported that existing advanced periodontal diseases do not progress if force is used within physiological limits and oral hygiene is maintained (Eliasson et al., 1982).

7. Multidisciplinary Solution of Aesthetic Problems

Some criteria should be considered for the control of gingival margin irregularities in the maxillary canine-canine region. If this irregularity is not visible and does not disturb the patient, it should be postponed until after orthodontic treatment. However, if it is in the visible zone and is severe

enough to disturb the patient, the clinical crown length can be extended by performing procedures such as gingivectomy and extrusion in the discrepant zone (Kokich, 1996).

The most common cause of interdental papillary loss is contact deficiencies. Radiography techniques are used to determine the treatment of this problem. If the root tips of the 2 anterior teeth are diverging from each other in the radiographs, the root angles are corrected orthodontically. If it is evident from the radiographs that there is no problem, then the problem is usually due to the triangular form of the tooth, and in this case the treatment is either interproximal striping or composite restorations (Kurth & Kokich, 2001).

Gummy smile appearance occurs mostly in middle-school-high school-age individuals due to the thick or fibroid structure of the gingival phenotype in cases where the migration of the gingival ridge to the apical is retarded. If the aesthetic problem is severe, the treatment is surgical (Konikoff et al., 2007; Theytaz & Kiliaridis, 2008). The treatment of gummy smile seen in patients with deep bite, such as Class 2 Division 2, is the intrusion of the incisor teeth (Lapatki et al., 2002).

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