EFFECT OF LASER THERAPY ON GINGIVITIS DURING ORTHODONTIC TREATMENT

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Abstract

Aim. The aim of our paper was identify the latest literature data regarding the minimally invasive periodontal management during the orthodontic treatment in order to establish a predictable clinical protocol.

Materials and methods. We have searched the main international data bases in order to identify the most representative publications related to the use of laser as a prophylactic (through biostimulation) but also as an interceptive method in modulating inflammation and in maintaining periodontal health during fixed orthodontic treatments. Results and discussion. The orthodontic treatment with brackets does not cause gingival inflammation per se, however, it may induce a both qualitative and quantitative change in the intraoral environment as to the oral microbiota, leading to an increased amount of microorganisms not only in saliva, but also in the dental plaque. Orthodontic brackets might impede a proper oral hygiene, thus contributing to the initiation of an inflammatory process by plaque accumulation and favoring gingivitis, gingival enlargement, increase in pocket probing depth, and bleeding on probing. Furthermore, elastomers are among the ligatures that accumulate bacteria and, although producers have manufactured elastic ligatures that release fluoride, their positive effect is questionable at best. Conclusions. Diode laser has remarkable properties that offer many benefits such as stimulation/inhibition of the physiological, biochemical, or proliferative activities at the periodontal level.

Keywords: laser therapy, gingivitis, orthodontic treatment.

1. INTRODUCTION

Oral equilibrium may be attained by a common method for correcting malocclusion, namely a fixed orthodontic treatment. The literature does not offer a common ground regarding the effect of a fixed orthodontic treatment upon periodontal health. The orthodontic treatment can improve facial aesthetics and mastication through teeth alignment. However, dental caries, tooth discoloration and gingival hyperplasia have been reported as complications of this treatment. The presence of orthodontic appliances, bands, and elastics makes difficult a suitable oral hygiene, such conditions possibly leading to plaque accumulation and changes in the composition and type of oral bacteria [1]. A prolonged persistence of brackets on teeth, more than two years, besides being a local factor predisposing to plaque accumulation, enhances enzymatic activation, particularly salivary esterase. Nevertheless, studies have suggested that gingival changes caused by the use of fixed orthodontic appliances do not produce permanent aggression of the periodontal support tissues. Due to the fact that a normal occlusion promotes a proper oral hygiene and that traumatic occlusion can be relieved through an orthodontic treatment, on the long term such patients are more protected against certain periodontal conditions [2,3]. Other authors have found that plaque accumulation and gingival inflammation, including bleeding, edema and gingival enlargement, are common during orthodontic treatment [4]. Therefore, it is likely that a fixed appliance could increase the risk of gingivitis, or even periodontitis, during the orthodontic treatment. The aim of our paper was identify the latest literature data regarding the minimally invasive periodontal management during the orthodontic treatment in order to establish a predictable clinical protocol.

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2. MATERIALS AND METHODS

We have searched the main international data bases in order to identify the most representative publications related to the use of laser as a prophylactic (through biostimulation) but also as an interceptive method in modulating inflammation and in maintaining periodontal health during fixed orthodontic treatments.

3. RESULTS AND DISCUSSION

The etiology of gingivitis and periodontitis is microbial infection, resulting in an unbalance between the host and the microorganism and a change in subgingival microbiota [5].

The host and the bacterial factors interact in regulating the progression of an initial gingivitis lesion to periodontitis, however inflammatory gingival changes are suggested as being reversible after bracket placement and after appliance removal. Various studies have investigated periodontal and microbiological changes following the orthodontic treatment.

Periodontitis is an infectious inflammatory disease of the tooth-supporting tissues, characterized by high morbidity and alternative occurrence of remission and acute exacerbation. As dental plaque accumulates and matures, the bacteria pass through the damaged epithelium and enter the blood stream. During this aggression, the mononuclear macrophages activated by humoral and cellular immunity release a number of inflammatory cytokines, such as high-sensitivity C-reactive protein, interleukin-1β, interleukin-5, interleukin-6, interleukin-8, tumor necrosis factor-a, and prostaglandin E2 [6-9]. Overexpressions of inflammatory cytokines can worsen periodontal inflammation, which is closely related to the development and progression of periodontal diseases.

Clinical treatments of periodontitis have gradually diversified into drug treatment, orthodontic treatment, and periodontal treatment. The periodontal treatment includes the removal of bacterial plaque and treatment of traumatic occlusion, which can effectively improve patient’s gingival bleeding, periodontal abscesses, and other periodontal symptoms [10-12].

Orthodontic treatment can suppress pathologic tooth migration, control bacterial plaque and establish a good occlusion to promote restoration of the periodontal tissues [13-15].

Currently, the fixed orthodontic therapy is the most preferred therapeutic modality for the treatment of malocclusions that affect mastication and facial appearance. Fixed appliances can change the subgingival microbial environment by increasing plaque accumulation and deepening the gingival sulcus. Although successful outcomes are achieved in orthodontic therapy, appliances can affect subgingival microbial composition and inflammatory reactions can develop in the gingival tissues of patients, particularly at early periods of therapy [16]. Some studies have reported microbial changes in the subgingival plaques of orthodontic patients, and found out that the content of periodontal pathogens in the subgingival plaque was significantly altered. Orthodontic tooth movement, including intrusion and tipping, can shift the supragingival plaque into the subgingival sulcus, thus affecting the subgingival microorganisms. The content and virulence of bacteria are highly related to host immunity. At host-microorganism equilibrium, periodontopathogens can appear in the subgingival plaques of periodontally healthy subjects. Therefore, the microbial baseline of different people varies. When the content of periodontopathogens is significantly changed, the host-microorganism disequilibrium will cause periodontal inflammation. In addition, the hormonal level affects periodontal inflammation and subgingival microorganisms, particularly in adolescent and pregnant orthodontic patients [17].

Metal ions, especially nickel ions, released from metal brackets and archwires could result in toxic effects on bacteria [18].

Generally, long-term observational studies evidenced a transient microbial change, namely that some periodontopathogens (Prevotella intermedia, Tannerella forsythia and Fusobacterium nucleatum) first increased, several months later returning to the pretreatment levels. For example, Thornberg et al. [19] detected microbial changes along the whole treatment, observing that the number of patients with high periodontopathogen
counts increased 6 months after orthodontic appliance placement, returning to the pretreatment level 12 months later [20-22].

Some authors have proposed appliances that may cause less plaque formation, such as self-ligating brackets. The advantages include the ability of having a better hygiene, as they do not require wire ligatures.

Elastomers are among the ligatures that accumulate a high amount of bacteria [23] and, although elastic ligatures that release fluoride have been proposed as a better alternative, they have not been proven effective and reliable in terms of attachment [24]. Comparing metallic and elastic ligatures, bacteriological findings assessed that elastic ligatures accumulate 38% more micro-organisms in the form of plaque compared to the metallic ones, thereby contraindicating the use of elastic ligatures in individuals with bad hygiene habits [25]. In terms of bleeding, results were substantially higher with the use of elastic ligatures [26].

Self-ligating brackets have been a major focus of attention in orthodontics in recent years, which explains the various designs developed by manufacturers. All have very similar characteristics and can be divided into two groups: active and passive brackets. It is speculated that active self-ligating brackets allow a better hygiene, as they do not have locks or clips completely closing the bracket slot and forming a fourth wall. Passive brackets, on the other hand, present a buccal wall and, for this reason, could cause plaque accumulation inside the bracket slot [27].

Three months after appliance removal, a significant reduction in the periodontopathogens found during orthodontic treatment was reported [28], as well as a significant decrease in the subgingival colony forming units (CFU aerobe/anaerobe) ratio. Clinical parameters, such as plaque index, gingival index, periodontal probing depth and gingival crevicular fluid decreased significantly 6 and 3 months after bracket removal [29]. Normalization of the plaque and gingival indices has even been reported 1 month after removing the fixed orthodontic appliance [30].

With the recent advances and development of a wide range of laser wavelengths, researchers suggest that lasers could be applied for dental - periodontal, restorative, surgical and orthodontic - treatments.

Low-level laser therapy (LLLT) is a light-source treatment that generates light with a single wavelength, acting through a nonthermal, photochemical reaction in the cells. It has been postulated that the photobiological action mechanism of LLLT is generated via activation of the respiratory chain; also, LLLT can modulate the periodontal inflammatory process mainly by reduction of prostaglandin E2 (PGE2) release. [31] Apparently, different pathways take place in inflammatory modulation. LLLT influences the expression of cyclooxygenase (COX) 2 and interleukin-1beta (IL-1b), [32] as well as matrix metalloproteinase (MMP)-8, platelet-derived growth factor (PDGF), transforming the growth factor (TGF)-b, basic fibroblast growth factor (bFGF), and plasminogen. The beneficial effects of LLLT were only observed when LLLT acted as a coadjuvant. LLLT modulates the process of tissue repair by stimulation of cellular reaction, such as migration, proliferation, apoptosis, and cell differentiation, and modulates secretion of the vascular endothelial growth factor and fibroblast growth factor secretion [33].

The advantages of laser utilization in repair treatments include reduction of patient’s physical and mental stress, due to a decrease in noise and vibration, increasing efficiency, as well as improved results, induced by decontamination, homeostatic and ablative effects, wound healing, pain relief, anti-inflammatory effect, blood microcirculation to traditional periodontal treatment. [34]
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LLLT is emerging as a useful tool to modulate the chain of biological processes triggered during orthodontic treatment, and also as a possible strategy for modulating inflammation and maintaining periodontal health during fixed orthodontic treatment [33].

Analysis of the specific biochemical indicators present in the GCF is a good option for evaluating the local cellular metabolism, which reflects the periodontal health status and bone remodelling during orthodontic treatments [30,31,34]. The orthodontic forces represent physical agents capable of inducing an inflammatory reaction in the periodontium. The reaction is necessary for orthodontic tooth movement; however, an excessive inflammatory reaction can delay this movement. Light continuous orthodontic force tended to maintain relatively high IL-1b levels for a longer period, so that it may reduce the frequency of reactivation [35]. The relatively longer-lasting levels of induced cytokines are needed for continuous periodontal remodelling [36,37].

IL-1b is effective for evaluating the periodontal inflammation and can be used as a laboratory tool for assessing the periodontal disease. The periodontal benefits of LLLT have been described in terms of a higher reduction of PD, bleeding sites, and periodontal inflammation, and decrease of the IL-1b levels in GCF even in the 1st month of implementation [31,38].

Additional treatment with LLLT slows down the slight periodontal deterioration, that is intrinsically caused by orthodontic treatment, and has a beneficial effect in controlling periodontal inflammation by lowering the BOP and PD scores, the bacterial load, while attempting at maintaining an equilibrium between bacterial aggression and host response; equally, it has a bactericidal effect on periodontopathogenic bacteria as well as in managing the pain caused by the monthly activation, thus allowing a faster recovery of the initial periodontal status.

Photodynamic therapy is a treatment based on the activation of an exogenous photosensitising agent by a light source, to produce cellular lesions. To obtain the desired effect, the color of the dye used must be compatible with the wavelength applied, and must have minimal toxicity and high absorption at resonant wavelengths. The bacterial-related photosensitizer can be light-activated with the appropriate wavelength, in the presence of

Fig. 1. a,b,c,d - LLLT performed with a Diode laser, 940 nm, on a patient with anterior crowding in the mandible before orthodontic treatment for the decontamination of periodontal pockets.
oxygen, to generate singlet oxygen and free radicals that are cytotoxic to microorganisms, mainly as a result of cytoplasmic membrane and DNA damage [39].

A possible concern of photodynamic therapy would be the potential photocytotoxicity for human cells, but it was demonstrated that the dose of light needed to kill the bacteria was much lower than the toxic dose for human keratinocytes and fibroblasts. Furthermore, some beneficial effects of the photodynamic therapy have been reported in periodontal ligament cells, such as inhibition of inflammatory mediator production, thereby favoring cellular chemotaxis and promoting local vasodilation and angiogenesis. Due to these beneficial effects, the photodynamic therapy has been successfully used in the treatment of pathological conditions with bacterial etiology, such as peri-implant and periodontal diseases, appearing as an invaluable aid in treating orthodontic patients affected by periodontal suffering. [40]

4. CONCLUSIONS

Laser has been successfully used in different dental areas, such as wound healing, orthodontic pain relief, stimulation of blood microcirculation, acceleration of the orthodontic movement and anti-inflammatory therapy. Diode laser has remarcable properties that offer many benefits such as stimulation/ inhibition of the physiological, biochemical, or proliferative activities at the periodontal level.

References


