Review Article

Rapid Orthodontics -A Low Level Laser Therapy To Accelerate Tooth Movement-A Critical Review

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ABSTRACT

Modulation of orthodontic tooth movement (OTM) is desirable not only to patients because it shortens treatment time, but also to orthodontists, since treatment duration is associated with increased risk of gingival inflammation, decalcification, dental caries, and root resorption.[1,2,3,4,5].Orthodontics has been rendered a more comprehensive speciality in cooperating facets of all field of medicine by increasing the focus on the biological basis of tooth movement.While acceleration of the orthodontic tooth movement bysurgicaltechniqueshasbeenshowntobeeffectivefor decades, noninvasive and nonsurgical methods have always been preferred by both the clinicians and the patients. Prolonged treatment duration is one of the main deterrents in orthodontics. Lengthy orthodontic treatment prompts many patients, especially adults, to either avoid treatment or to seek shorter alternative solutions with compromised results. Current knowledge raises the possibility of using new therapeutic modalities for modulation of Orthodontic tooth movement, such low level laser therapy,because it is easy, noninvasive technique with the advantage of additional pain relieve rather than accelerating patients' stress by anadditional invasive surgicalintervention. Therefore the present study will determine the current status of the relationship between orthodontic force and the rate of subsequent tooth movement under the use of Low-level laser therapy to assess the methods, procedures, and variables applied by different authors in theirclinical trailsand evaluate the aspects that remain to be studied.

Keywords-Low-level, laser therapy, Orthodontics, tooth movement

Introduction

In recent times, with increase demand for orthodontic treatment, accelerating tooth movement becomes a significant interest to the orthodontist and has recently been the focus of different studies. Prolong treatment duration not only decrease the quality of life of patients, but also associate with increased risk of Decalcification[1],dental caries, root resorption[2,3] and periodontal problems.[4,5] Thus, reducing the duration of treatment is highly desirable since it offers aesthetics convenience and decreases the likelihood of aforementioned adverse events to the patients.Clinicians are constantly striving towards developing new strategies to enhance the rate of orthodontic tooth movement and reduce the treatment duration.

A number of methods have been introduced recently for the purpose of accelerating tooth

movement in order to provide treatment choices to the patient which are better and less time consuming. These treatment options includenonsurgical methods using biochemicalagentssuchasa local injection of 1,25 (OH) $_2$D$_3$ [6, 7],prostaglandins [8, 9]or osteocalcin and alterations in alveolar calcium metabolism.[10] On the other hand, there are Surgical means like corticotomy, [11]peizocision,periodontal distraction, dentoalveolar distraction, and molecular therapies [12]which increases the bone turnover and decreases the bone density to accelerate tooth movement. Another recent therapeutic approach to enhance the rate of tooth movement is the technique of photobiomodulationor laser therapy. The exposure to low-level laser light is described to be anoninvasive method, which is painless and is not associated with any systemic effects. [13,14,15,16] The purpose of this reviewarticle is to summarize the studies on low-level laser therapy on orthodontictooth movement,and finallytheresultsofdifferent research projects are discussed.

Orthodontic Tooth Movement (OTM)

OTM is a biological process characterized by PDL and alveolar bone remodeling in response to an orthodontic force which will promote extensive cellular and molecular changes in the periodontium. Bone remodeling is a process of resorption of bone on the pressure site and deposition on the tension site[17] .The two factor which control the Orthodontic tooth movement includesthe size of the applied force and the biological responses from the PDL [18]. The force applied on the teeth will cause changes in the microenvironment around the PDL due to alterations of blood flow, leading to the secretionof different inflammatory mediators such as cytokines, growth factors, neurotransmitters, colony-stimulating factors, and arachidonic acid metabolites. As a result of these secretions, remodeling of the bone occurs.[19,20]

Lasers in Orthodontics

The Laser (Light Amplification by Stimulated Emission of Radiation)ismonochromatic, emits light through a process of optical amplification based on the stimulated emission of electromagnetic radiation.[21]

Lasers can be classified based on their potency and mechanism of action:-

1. High-intensity lasers, such as the CO2 laser, Nd laser: Yttrium aluminum garnet (Nd:YAG) , Er:YAG laser, argon laser and the excimer laser act by increasing the temperature, showing a destructive potential, and are usually used in surgical procedures.[22]
2. Low-intensity laser (also known as soft laser, laser therapy or cold laser) does not have a destructive potential. Its photobiomodulation mechanism of action penetrates tissues and stimulates cellular metabolism, bone remodeling and tooth movement which is of greatest interest in the field of Orthodontics.[23]

Different low-energy laser modalities have been used in different doses and in various treatment protocols, including helium-neon (632.8 nm wavelength) and semiconductor lasers (emitting light in the range of 780–950 nm), gallium-aluminum-arsenide (GaAlAs) (805 ± 25 nm wavelength) and gallium-arsenide (904 nm wave-length).[24]

Low-level laser therapy has been introduced to control pain because of its anti- inflammatory action and regenerative effect on neurons .It may increase the blood supply and promote recovery of dental tissue.[25]

GaAlAs diode laser has proven to have higher depth of tissue penetration in comparison to other modalities, therefore, providing the clinicians with a suitable penetrative instrument with great efficiency in orthodontic treatment. The exposure to low-level laser light is described to be anoninvasive method, which is painless and is not associated with any systemic effects and is convenient for soft tissue surgical procedures in orthodontics. Furthermore, it is described to be simple to perform and notrequiring expensive equipment.[26]

LASER APPLICATIONS IN ORTHODONTICS[27]

- Exposure of uneruptedor partially erupted teeth.
- Reduction of Orthodontic pain. [25]
- The treatment of traumatic ulcers in the oral mucosa.
- Cosmetic gingival contouring
- Smile designing

- Crown lengthening.
- Establishing tooth proportionality before bracket placement.
- Soft tissue management of orthodontic patients.
- Frenectomy, gingivectomy.
- Simulation of intraoral laser microwelding of orthodontic appliances.
- Debonding.
- Enamel etching for bonding.
- Enamel decalcification reduction.

Discussion

Research in the field of orthodontic tooth movement (OTM) has evolved rapidly and it changed considerably since the work of Reitan et al in the year 1950s.[28]Cruz et al. [29] were the first to publish research results on the effect of Low-intensity laser therapy (LILT) on the duration of dental movement in humans. They conducted a split-mouth design study with 11 subjects,between12to 18yearsofage,whoreceived mechanical activation for the retraction of their upper canine teeth in the space of extracted premolars every 30 days. Each tooth was receiving the same mechanical activation, but one of them was also receiving LILT with a diode laser emitting light at 780 nm, during 10 s at 20 mW, 5 J/cm^2, on 4 days of each month. According to their results, orthodontic movement of the treated teeth was accelerated due to the use of laser radiation. Since then, more clinical studies inhumans have also revealed a significantly positive effect of low-intensity laser radiation on the acceleration of orthodontic tooth movement.

Xu (wavelength: 632 nm; output ower: 20Mw;Power density: 2.5 J/cm^2) and Wang[31](wavelength: 780 nm; output power:20mW;Power density: 5 J/cm^2)showed similar results of a significant higher acceleration of canine retraction due to low level laser therapy

Youssef et al. [32] (wavelength: 809nm; outputpower:100mW;Power density: 8 J/cm^2)were also observed a significant greater velocity in canine retraction using a low-level laser therapy. Sousaetal.[34]tested the influence of low

Gui and Qu[33](wavelength: 650 nm;output power:20mW;Power density:25J/cm^2) also found significant result with low- level laser therapy.

low-level laser irradiation to speed up the canine retraction in 13 patients. The irradiation protocol included an irradiation with a diode laser (780 nm/20 mW/10 s, 5 J/cm^2) for 3 daysand thepatientswerefollowedupfor4months.

A significant increase in movement speed was found on the irradiated side compared to the contralateral control side without irradiation.

Doshi-Mehta[35] (wavelength: 810 nm;outputpower: 80mW; power density: 20 J/cm^2) and Genc et al. [36](wavelength: 808 nm; output power: 20 mW; power density: 0.71 J/cm^2) also observed statistically significant differences with regard to the rate of orthodontic tooth movement . But Limpanichkul etal.[37]reported that LILT with the useof Ga-Al-As(wavelength: 860 nm; continuous wave power output: 100mW;powerdensity:1.11W/cm^2;energy dose: 2.3 J/point; energy density:25J/cm^2/site) didnotseeanyeffect on the rate of tooth movement. The discrepancies may be explained by the different treatment protocols used in these studies, including the wavelengths of the lasers, irradiation doses, locations and frequencies. The following table contains the studies done by various researchers on low-level laser therapy for the accelerated orthodontic tooth movement (Table 1)

Conclusion

In this review, we observed that most authors reported positive effects of the use of Low- level laser therapy on rate of orthodontic tooth movement when compared with control or placebo groups but there are few studies that showed no response to rate of tooth movement. These discrepancies may be explained by the different treatment protocols used in these studies, including the wavelengths of the lasers, irradiation doses, locations and frequencies. Because of the wide variety of combination and the different protocols applied, further studies are necessary to show results and help to determine the correct dosage, energy level and applying protocol to offer the most efficient support in orthodontic therapy. Nonsurgical techniques are more preferable for orthodontic patients, as described are noninvasive, painless,easy to perform and in general more attractive toorth odontic

patientsandclinicians when compared with surgical procedures.

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