Review Article

Lasers in Orthodontics – A Review

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ABSTRACT

Introduction: In past few years, there is huge improvement in orthodontics. Different innovation in orthodontics made the procedure easier and less time consuming. Application of laser is one of them. Many types of dental lasers are currently available that can be efficiently used for soft and hard tissue applications in the field of orthodontics. Two types of lasers are there. One is hard tissue laser, and another is soft tissue laser. Laser therapy is advantageous because it often avoids bleeding, can be pain free, is non-invasive and is relatively quick. The high cost is its primary disadvantage. The purpose of this article is to provide an overview regarding safe and proper use of soft-tissue lasers in orthodontics.

KEYWORDS: Laser, Laser Etching, Laser Debonding, Laser Frenectomy, Orthodontics

INTRODUCTION

Laser is the acronym for "Light Amplification by Stimulated Emission of Radiation" that dates back to approximately 50 years ago. A laser is a single wavelength of light traveling through a collimated tube delivering a concentrated source of energy. Most elements in the periodic system (atoms, gases, organic molecules, diodes, chemicals, or electrons) can be used as media to develop a laser beam.1Laser was developed by Theodore H. Mmaiman in 19602. This was followed within 3 years by the development of argon, carbon dioxide, and neodymium: yttrium-aluminium-garnet (Nd: YAG) lasers, which remain the most widely used lasers in medicine. In 1968, carbon dioxide was used to perform the first soft-tissue surgery. For dental laser systems, the light is typically delivered to the target tissue through an optical fiber cable, a hollow waveguide or an articulated arm3. Lasers used in dental practice vary between wavelengths of 488 nm and 10,600 nm.

Application of laser in orthodontics

Now a day's laser is being used widely in dentistry as well as in orthodontics. There are two types of lasers.

1. Hard tissue laser
2. Soft tissue laser

Both types of laser are used in orthodontics in different procedures.

Classification of lasers[4]

1. According to strength
    - Hard laser (used in surgical work)5
    - CO2 laser
    - Nd: YAG lasers
    - Argon lasers
    - Soft laser (use for bio stimulation and analgesia)

2. According to their transmission system
    - Glass fiber systems-CO2 lasers
    - Mirror system
    - Nd: YAG lasers
    - Argon lasers
    - He-Ne lasers
    - Diode lasers
    - Q-switched Nd: YAG lasers

Both glass fiber and mirror system-pulsed excimer lasers

3. Classification of lasers based on their clinical uses

Laser type	Wavelength	Main current clinical uses
Argon	488, 514.5 nm	Curing, soft tissue desensitization
Diode	800-830, 950-1010 nm	Soft tissue, periodontics
Nd: YAG	1064 nm	Soft tissue, periodontics, desentization, analgesia, tooth whitening, and endodontics
Er. YSGG	2.79 μm	Hard tissue
Er. YAG	2.94 μm	Hard tissue
CO2	10.6 μm	Soft tissue, desensitization

DENTAL LASERS

Argon laser- The argon laser, the active medium of which is argon gas, produces light at two wavelengths. The 488 nm blue light is commonly used to initiate the polymerization of restorative composite materials. The 514 nm blue-green light has maximum absorbance in tissues that are composed of pigmented molecules such as hemosiderin and melanin. Both wavelengths of the argon laser are poorly absorbed by non-pigmented and hard tissues[3]. Commonly used for hemorrhage control in gingival surgery, as well as for detecting cracks and decay on the surface of teeth by using the transillumination technique[6].

DIODE AND ERBIUM LASERS

Currently, the 2 most popular types of lasers used in dentistry are the diode and the erbium lasers. Diode lasers are almost exclusively used for soft-tissue surgery. Diode lasers are packaged in small, portable units (typically weighing less than 10 lbs). Connecting to the main unit is a thin, pencil-size handpiece containing a 400-μm lasing fiber. Before surgery, some diode lasers must first be conditioned or primed. Priming is the process of concentrating heat energy at the tip of the laser fiber.[3] This is done by simply taping the fiber on articulating paper while the laser is energized.[3] After the surgery, the end of the fiber (2–3 mm) is cleaved to expose a fresh tip. The glass fiber optic is scored and removed to prevent cross-contamination. Diode laser wavelengths approximate the absorption coefficient of soft-tissue pigmentation (melanin). Therefore, the light energy from the diode is highly absorbed by the soft tissues and poorly absorbed by teeth and bone. These lasers can be safely used for soft-tissue surgery applications, including gingival recontouring, crown lengthening, removal of hypertrophic tissue and frenectomies close to the enamel, dentine and cement.

The advantages of the diode laser include the following:

(1) They have excellent soft-tissue absorption and hemostasis
(2) It is difficult to damage hard tissues
(3) They can be used in contact mode, which provides tactile feedback
(4) They can be used for tooth bleaching
(5) They are compact and low-cost[6].

Erbium lasers can be used for hard- and soft-tissue surgeries. Types of erbium lasers used in dentistry include the Er:YAG and Er, Cr:YSGG.[3,8] The Er:YAG laser (2,940 nm) has YAG as its active medium, while the Er, Cr:YSGG (2,790 nm) has solid yttrium, scandium and garnet. During surgery with an erbium laser, the fiber tip should be held 1 mm from the tissue[9]. Excision is performed with slow, short back-and-forth strokes. Coagulationn is achieved under a different setting, with low wattage and no water. An erbium laser can effectively control hemorrhaging, but strict hemostasis can be difficult because the laser operates in the pulsed mode[10,11]. Tissues appear slightly reddish during excision and chalky white after coagulation.

The advantages of the erbium laser include the following:

(1) priming is not required
(2) the fiber-optic tips are autoclavable.

Disadvantage- size and cost of the operating unit. The main unit requires 80 psi of air pressure provided by an external source such as an operatory bay.

Lasers in Orthodontics-Clinical Applications

1. LASER ETCHING

Application of laser on enamel causes localized thermal ablation and removal of enamel surface[12]. It is due to micro explosion of entrapped water in enamel and there may be some melting of the hydroxyl-apatite crystals. It causes surface roughening similar to acid etching by 37% phosphoric acid with a depth of 10-20 micron[13]. But it should be used at high power output.

2. LASER CURING

The extended placement time offered by light-cured adhesives allows more accurate bracket positioning. The major disadvantage of these adhesives has been the 20-40 s required to set each bracket with a curing light. Argon laser is widely used in laser curing. BisGMA, the most common monomer in composite adhesives, is polymerized when one of the double bonds at either end of the polymer is broken and then attached to another BisGMA polymer. The photo initiator system cures in the blue region in the visible light spectrum in 480nm wave length. Talbot et al. found that argon laser can cure composite achieving similar bond strength compare to normal light cure units[14].

3. LASER DEBONDING

CO2 and ND: YAG laser is commonly used for laser debonding. Debonding by laser causes decreased adhesive remnant index. Also, the chances of enamel damage are less in laser debonding. This approach has been shown to be efficient for de-bonding, resulting in a decreased adhesive remnant index and a relatively small increase in pulp temperature. With the application of laser irradiation, the adhesive resin can be softened, allowing light force to be applied during debonding. An Nd:YAG laser applying at 2 J or more is effective during the removal of monocrystalline and polycrystalline ceramic brackets, although it significantly decreases the bond strength to a greater extent for the polycrystalline ceramic brackets than for monocrystalline brackets[15]. Ceramic brackets can easily be debonded with this technique[16].

4. REDUCING PAIN DURING ORTHODONTIC FORCE APPLICATION

It is well-known that following the application of orthodontic appliances, the patient feels pain or discomfort for 2-4 days. Low-level laser therapy (LLLT), in which the energy output is sufficiently low to prevent a temperature rise above 36.5°C (normal body temperature) in the target tissue[17], can be used as a convenient analgesic therapy for orthodontic patients[18]. Tooth movement occurs due to PDL and bone remodeling. LLLT increases this remodeling procedures and decrease treatment duration. LLLT is also effective in reducing orthodontic pain[19].

5. EFFECTS ON BONE REGENERATION

A number of studies in the literature have shown that LLLT increases fibroblast proliferation and the quantity of osteoid tissue[20-22]. The first is stimulation of cellular proliferation, especially nodule-forming cells of osteoblast lineage.The second is stimulation of cellular differentiation, especially to committed precursors, resulting in an increase in the number of differentiated osteoblastic cells and an increase in bone formation. According to Angeletti et al. bone regeneration can be accelerated during the early stages of laser therapy. These results are important for orthodontic practice. However, it is important to remember that the outcome of LLLT on bone regeneration after midpalatal suture expansion depends on total laser dose, the frequency of irradiation and the application timing[21].

6. SOFT-TISSUE APPLICATIONS RELATED TO ORTHODONTIC TREATMENT

Dental lasers provide convenience and accuracy during soft-tissue incision. They cause minimal tissue damage, provide hemorrhage control and can also reduce post-operative pain. Soft-tissue applications related to orthodontic treatment include gingival recontouring, exposure of unerupted and partially erupted teeth, removal of hypertrophic and inflamed tissues, frenectomies, miscellaneous tissue and treatment of aphthous lesions[23]. Exposure of impacted tooth can be done safely by laser. Soft tissue laser like diode laser can be used for this procedure.

Hazards of laser therapy

Though laser is a good alternative in orthodontics, there are few hazards related to laser therapy.

1. Ocular hazard
2. Tissue damage
3. Fire and explosion
4. Electrical shock
5. Combustion hazard
6. Equipment hazards.
7. Respiratory hazards

CONCLUSION

Lasers have become a ray of hope in dentistry. When used safely, it can perform a work very precisely and efficiently. So, laser can be a very efficient tool in different procedures in Orthodontics. But a lot of modification has to perform for patient safety and to reduce cost of the treatment.

OJN

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