A REVIEW ON APPLICATION OF LASERS IN ORAL MEDICINE

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***Abstract*: Lasers are known as light amplification by stimulated emission of radiation. Lasers are intense beams produced by stimulated emission of radiation from a light source. Einstein identified that a laser is promoted by the emission of radiation as a natural process. When a beam of light passes through a specific medium causing stimulation of the atoms within the medium to transfer the light in a specific direction, that is, the same direction as the medium by the same wavelength as that of the original beam, a laser beam is created. Lasers are capable of increasing light intensity to synthesize beams of an effective wavelength, which are directional and of a high intensity. Many specialties in dentistry including oral surgery, implants, oral medicine, periodontics, pediatrics, and operative use the current new laser technology. The ability of lasers to provide minimally invasive procedures with less discomfort to the patient has been useful in the patient delivery system in dental practice. This article describes in brief on the uses of lasers in oral mucosal lesions.**

***Keywords*: oral medicine; laser; beam; minimal invasive; dentistry**

INTRODUCTION

In 1917, Albert Einstein set the foundation for the invention of the laser by explaining the photoelectric amplification, and it was introduced to the public in 1959. Miaman was the first person who used the laser in 1960 on the hard and soft tissue. Advancements in the application of lasers over the last two decades have extended their use in caries prevention, bleaching, cavity preparation, dentinal hyper-sensitivity, growth modulation as well as for diagnostic purposes. In the soft tissue, it has been used in wound healing, the removal of hyperplastic tissue to uncover impacted or partially erupted tooth, photodynamic therapy of malignancies, and photo- stimulation of herpetic lesion.

It has been discovered that lasers have increased the efficiency, specificity, ease, cost, and comfort of dental treatment. In the early 1960s, it was noted the use of medical lasers in dental applications had limited application. In the early decades, the physicians realized that the light allowed them to observe many things such as skin color and wounds, and it helps them in choosing the most effective therapeutic course of action. This led researchers to explore the specific applications of lasers in the medical and dental fields.

In the mid-1960s, enhanced methods of caries removal were reported, performed by an effective interaction of laser energy with tooth structure. Ruby lasers were very useful in vaporizing caries but they caused irreversible necrotic changes in the pulp tissue because of the high energy densities. Then, the Erbium Laser wavelengths were discovered, which did better in terms of the cavity preparation without damaging the pulpal tissue. Argon lasers were found to be effective in the photo- polymerization of dental

composites and Nd:YAG (neodymium-doped yttrium aluminum garnet) lasers were effective in various endodontic therapies, prosthetic devices, gold alloys, and prosthetic devices.

In 1990, the Food and Drug Administration (FDA) approved the use of laser therapy in intraoral gingival and mucosal tissue surgery as it ensured a wound without suture, pain, and bleeding and increased the convenience for the dentist. The first laser designed specifically for the dentistry was introduced in the United States on May 3, 1990, by Myers. Among the various special lasers designed to be used for soft tissue procedures and for the teeth and bone, it has been seen that the erbium wavelength is very safe and effective. Lasers, either in therapeutic or photo- bimodulation, have shown effective results in healing. The first clinical results of photo-activated disinfection also showed good applications for disease control.

MECHANISM OF ACTION

The laser consists of an energy source, an active lasing medium, and two or more mirrors. In the dental laser, the light reaches the target tissue via the fiberoptic cable, hollow wave guide, focusing lenses, and cooling system. The Amdt–Schutz principle is the basis for the action. This means that the increase or decrease of the stimulus beyond the optimal dose will lead to weakening or absence of the effect. The optimal effect is created with the optimal dose. Accordingly, the bio stimulation effect of LLLT can be produced by optimal dose exposure to tissues in a non-contact mode.

In addition, LLLT deposits sub-thermal energy within tissues, which acts on the sub-cellular component. The application of LLLT also stimulates various cells lymphocytes and mast cell which will produce anti-inflammatory actions causing changes in the capillary hydrostatic pressure which results in oedema absorption and elimination of intermediary metabolites. Even it can increase collagen production, the mitotic activity of epithelial cells and fibroblast. Moreover, it can produce an analgesic effect by inhibiting nociceptive signals.

There are two types of beams used in dentistry, which are the visible beam like the argon laser and the invisible beam in the infrared range like the carbon dioxide laser, erbium substituted yttrium aluminum garnet, erbium chromium doped yttrium, scandium gallium garnet holmium, yttrium aluminum garnet, and gallium arsenide. There are many properties of the laser beam, especially the wavelength and optical features of the specific target tissue, which show the type and the extent of the interaction that might occur. The lasers used for surgical purposes emit light at specific wavelengths which have direct effects on the tissue not only on the coagulation and vaporization but also on the natural healing process of the cells. There are other kinds of lasers other than surgical lasers that are used as bio stimulators.

LASER IN ORAL MUCOSAL LESIONS

Lichen planus is a type of disease which has an unknown cause. The T-lymphocytes are the ones that are responsible for the pathogenesis. It has two forms of keratotic, which are the white lesions having no symptoms and no treatment is needed and non-keratotic which is the red lesion requiring treatment to relive the symptoms and to reduce the malignant action of it and there are many ways in treating this lesion like corticosteroids, photo- chemotherapy, lasers, and surgery.

LLLT was introduced especially for treating the erosive lichen planus type with very minimal side effects. In addition, there are two types of effects that a low-level laser produces: primary and secondary. Primarily, it causes vasodilation, lymphatic drainage, cellular activity and metabolism, enhancement of the flow of blood, activation of fibroblast and neutrophils, and stimulation of pain threshold. The secondary effect is the aggregation of prostaglandin, immunoglobulin and lymphocytes, and beta-endorphin in the tissue encephalin. Therefore, this will reduce infection and inflammation, pain, soreness, and immune response.

Many kinds of LLLT, which are used to treat oral lichen planus, include ultraviolet (waves of below 350 nm length), Helium neon (632 nm), and diode (red infrared wavelengths 600 to 1100 nm) lasers and these premalignant lesions like oral lichen planus can interfere with daily activities like eating and speaking. Corticosteroids is the first treatment one can go for in these cases, but we should be careful because it has many side effects. Diphenhydramine or local anaesthetics might be used in conjunction with corticosteroids and antifungal to treat cases of candidiasis, but it may reduce the patients' compliance.

Some studies showed lesions and pain remission by using a 630 nm laser for 10 sessions a month with the power of 1.5 J/cm2. Trehan et al used a 308 nm excimer laser in eight non-responsive painful oral lichen planus and the sessions were every week for 7 months and 1-400 power was emitted. In a study by Köllner et al, 75 to 150 mJ/cm2 powers of a 308 nm excimer laser were emitted to oral lichen planus lesions 3 times per week for 32 sessions.

One patient showed remission after 12 sessions with no signs of relapse one month later. Four patients were relative and 2 were absolute non-responders. Pain was gone after 10 sessions in this report. A 308-nm excimer laser emits ultraviolet B (UV-B) rays with a tissue penetration of less than 0.3 mm, whereas a 630 nm red light laser penetrates deep into tissue with a reduction in the inflammatory response, pain, and ulcer healing effects. The UV-B excimer laser is potentially a carcinogen; erythema, erosion and soreness are other side effects of its use, but no side effects were reported on the application of the red laser.

Erosive lichen planus is mainly treated by a 630 nm low-level laser which decreases the pain and soreness without side effects. The therapy of lichen planus by a diode laser has shown that it can reduce the reliving signs and symptoms of oral lichen planus. LLLT also showed very good results as an alternative treatment. Er-YAG lasers were effective in minimizing lymphoplasmacytic infiltrate.

Clinical case reports have shown that CO lasers are very good at treating histopathologically diagnosed lichen planus as they produce very good results.

Oral leukoplakia has also shown regression with laser therapy. CO2 lasers are very beneficial in treating oral leukoplakia. It causes minimal swelling and pain. Photodynamic therapy with 5-aminolevulinic acid and a pulse dye laser is used to maintain the regression of the leukoplakia. Although it is less invasive and painful and it shows better aesthetics, there has been a reoccurrence of the dysplastic oral leukoplakia after oral surgery in the instances of smoking directly after the surgery. So changes in oral habits have a great influence on the outcome of the laser surgery.

Oral mucositis which is considered as the most painful oral lesion requires narcotic analgesic and can reduce the quality of life. Factors that influence the growth of the oral mucositis are chemotherapeutic regimen, the type of malignancy, patients' age, neutrophil counts and the use of oral care measure. There are many side effects for the oncologic therapy such as ulcerations, alopecia, thrombocytopenia, neutropenia, and oropharyngeal mucositis.

The condition is worsened if accompanied by poor oral hygiene, pre-existing intraoral lesions, deficient immune status, and high-level pro-inflammatory cytokines. The most involved tissues are the non- keratinized tissues, the lateral borders of the tongue, and the floor of the mouth, and many therapeutic and preventive measures such as analgesics, cryotherapy, antibiotics, anti-inflammatory agents' growth factors and biological mucosal protectants should be considered. The application of LLLT has shown a significant reduction in the pain associated with oral mucositis as well as quicker healing of the oral lesions. Fordyce granule excision using a combination of the low-intensity and high-intensity lasers has produced increased aesthetics results and quicker healing with reduced postoperative pain and inflammation.

EFFECTS OF LASERS

The initial clinical experimental uses of lasers in dentistry were in 1964. The otolaryngologists, periodontists, and oral surgeons were the first specialists who used medical lasers intraorally to perform surgical applications in the soft tissue. Laser surgery in the sites, which have a lot of bleeding like cheeks, the floor of mouth and tongue provides good access to and control for the surgery.

There are many dental indications of LLLT. Anaesthesia has shown a positive effect on reducing the trauma to vessels or nerves that may be caused by the puncture of the needle in some cases. LLLT can be applied directly to the superficial mucosa before the injection, which will produce a good aesthetic effect, but it cannot be applied to the hard palate. Oedema, which is due to an increased inflammatory process depends on the lymphatic system. If LLLT is applied directly to the lymph nodes, it will reduce oedema.

Widespread oedema will need high doses and multiple visits to get relieved. Pain is limited with therapeutic lasers as they reduce the velocity of nerve conduction and action potentials as well as the suppression of noxious stimulations. Initially, in acute pain, there will be a decrease in the level of PGE2 and other inflammatory markers by direct inhibition of peripheral afferent terminals which suppress peripheral sensitization and limit the releases of neurokinins. The high doses of lasers will reduce the inflammatory cells and processes, thereby reducing the pain sensations.

In chronic conditions, it differs as it depends on the sensitization more than inflammation. Dental lasers are beneficial as there is an interaction of the specified area of the diseased tissue and a great reduction in the number of bacteria and pathogens with the use of lasers in the surgical field. In case of the soft tissue procedures, they achieve sufficient healing which may sometimes eliminate the use of sutures. Many researchers have seen that the effects of a laser can reduce the effects of edema because it seals the blood vessels and lymphatic channels properly.The light energy that is produced from the laser machine has interaction with the diseased tissue.

First, by the reflection of the beam that is redirected off the surface which has no effects on the targeted tissue and if the light maintains its collimation through the narrow beam, it might become more diffuse. But this reflection may cause harm as it could be reflected onto the non-targeted tissues like the eyes; for e.g. when the CO2 lasers are using in the exposure of titanium implants, they cause a more diffuse reflection. By the transmission directly through the tissue, there is no effect on the targeted tissue, depending on the wavelength of laser lights. Scattering of the light makes the intended energy weak. This is important in the infrared lasers for healthy soft tissue, and this will cause the photons to change their directions. Absorption of the laser energy is the usual desirable effect and the amount of absorption will depend on the pigmentation and water content.

Therapeutic laser light is a kind of light that stimulates the biological process and affects mostly the cells in an oxidation reduction reaction. The cell will be acidic in this stage but after the laser is done, the cell will become more alkaline and less acidic and will be able to perform its normal functions. The most important thing is to increase the adenosine triphosphate and it is mainly produced at the end of the Krebs cycle where the photon acceptor enzyme cytochrome is inhibited by nitric oxide. The laser light will initiate the binding between the nitric oxide and cytochrome-c oxidase, which will allow it to resume the action and production of the adenosine triphosphate enzyme.

The principle is to supply the direct bio-stimulative energy to the body cells, and cellular photoreceptors will also absorb the low-level laser light which will produce ATP. The photochemical theory is the most accepted theory that is shown to explain the effects

and the mechanisms of lasers, by which the light is absorbed by specific molecules and then some biological events will happen. Photoreceptors are some kinds of endogenous proteins and molecules in the respiratory chain such as cytochrome c-oxidase that will lead to increased ATP. This type of laser has been used for about 30 years and there are still no certain reports of harms caused by it.

Electromagnetic energy is available in waves from the tiny gamma rays, with wavelengths of about 10-12 m and thousand meters of the wavelengths to the radio wave. The current available dental laser instruments have emission wavelengths for about 488 nm to 10600 nm and all of them are in the non-ionizing radiation category. This is to be differentiated from the ionizing radiation whose effect on DNA has been shown to be mutagenic. The dental lasers produce thermal, heat and radiation. Some dental lasers emit light that is visible.

For instance, argon lasers emit blue light of 488 nm and as the frequency is doubled, they emit blue and green light of 514 nm. Of the two main instruments that emit visible light, the Nd:YAG emits mainly the green light at a wavelength of 532 nm, and the low level lasers emit light at a wavelength of 635 nm for photobiomodulation and at a wavelength of 655 nm low level lasers can be used for caries detection. Other laser devices that are used for soft and hard tissue surgery produce the laser on the middle, near infrared part of the electromagnetic spectrum, with one exception which is the low-level laser in the range of 810nm.

Surgical diode lasers ranging between 800-830 nm diode use an active medium which consists of aluminium, gallium and arsenate; this media is also used in a 980 nm diode laser as well as that of a 1064 nm diode laser. Nd-YAG lasers include YAG which is the crystals of yttrium scandium, gallium and garnet doped with erbium and chromium; however, Er;YAG at a wavelength of 2940 nm uses erbium as the doping agent and a wavelength of 10 600 nm utilises carbon dioxide.

CONCLUSION

The application of laser treatment in maxillofacial medicine has potential implications for quicker treatment and faster healing. The soft tissue laser is a state of the art tool that creates predictable aesthetics results within general dental practice. Lasers have significantly contributed to dental clinical practice in the 21st century and they will play a very important role in the dental practice in the coming future.

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