

Laser in Dentistry - A Review

Abstract:

Light Amplification by the Stimulated Emission of Radiation, or LASER, is what the phrase refers to. In 1960, Maiman was the first to apply laser technology on both hard and soft tissues in dentistry. Over the past two decades, laser technology has advanced significantly. Soft tissue applications include wound healing, removal of hyperplastic tissue for uncovering of impacted or partially erupted teeth, photodynamic therapy for malignancies, and photostimulation of herpetic lesion. Various hard tissue applications include caries prevention, bleaching, restorative removal and curing, cavity preparation, dentinal hypersensitivity, growth modulation, and for diagnostic purposes. Although lasers have been shown to be slightly more expensive than conventional therapy, they are a useful tool for improving the effectiveness, specificity, ease, and comfort of dental treatment.

Key-words: Argon, CO₂, Enamel, Lasers, Nd : YAG

Introduction:

Light's therapeutic properties and potential for healing are not a modern discovery; Greek and Egyptian physicians used sunshine to treat patients. The creation of laser devices for use in anything from CDs and DVDs to conducting operations and curing illnesses, however, was one of the greatest technical advances of the 20th century.[1]

The term laser is an acronym for :

Light Amplification by Stimulated Emission of Radiation.

Theodore H. Maiman invented the laser for the first time in 1960.

A laser is a device that induces the emission of light at certain wavelengths from atoms or molecules and amplifies that light, usually creating an extremely narrow beam of radiation. Depending on the optical characteristics of the target tissue and the laser wavelength utilised, the light energy from a laser can interact with the target tissue in four different ways. Depending on the amount of water in the tissues, when a laser is absorbed, it raises the temperature and creates photochemical reactions. Ablation is the process of vaporising

the tissue's water when a temperature of 100°C is attained. The surgical lasers emit light at certain wavelengths that directly affect the tissue, causing coagulation and vaporisation as well as the cells' normal healing process. Different than surgical lasers, other types of lasers are employed as bio stimulators..[2]

The main types of lasers used in dentistry are – [2,3]

Hard tissue lasers include those that use the YAG family of materials, such as ErYAG (erbium yttrium aluminium garnet), ErCrYSGG (erbium chromium yttrium selenium gallium garnet), and HoYAG (2100nm–2940nm), as well as CO₂ (carbon dioxide, 10600nm) (holmium yttrium aluminium garnet). These are mostly used as soft tissue lasers, and one of their wavelengths, NdYAG (neodymium, yttrium aluminium garnet), is an efficient dental laser for soft tissue.

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Dental technology has seen a lot of new breakthroughs over the past 20 years, and the coming 20 years seem to see even more. In the forefront of that expansion will be lasers. [4]

Dental Uses of Lasers Soft Tissue Applications:

1. Biopsy- We can categorise biopsy as incisional or excisional based on the technique utilised. Excisional biopsy is the complete eradication of the lesion, enabling both a diagnostic and therapeutic operation to be carried out concurrently. The incisional biopsy entails the removal of one or more fragments that are typical of the lesion, together with the deep and surrounding tissues, and it is only after the histological investigation that the therapy for any leftover lesions can be determined. Laser biopsy should be excisional and encompass at least 1 mm of healthy tissue beyond the border unless the lesion is particularly big (i.e.> 2 cm) or seems malignant. To do this, the incision should begin at least 1.5 mm to 2 mm from the border due to the breadth of the majority of laser fibres.

In comparison to knife biopsies, laser biopsies have several benefits. Typically, these procedures don't call for anaesthesia or sutures, and the donor site heals more quickly, at least at first. The diode laser, KTP laser, CO2 laser, Nd: YAG laser, and Er: YAG laser are the lasers that are most frequently employed for this purpose.

2. Oral Mucosal pathologies (Red and White lesions)/Hyperkeratotic lesion – [5]

Leukoplakia - The incision should begin at least 1.5 mm to 2 mm from the border in order to accomplish this due to the breadth of the majority of laser fibres. The use of a laser instead of a knife has several benefits over traditional biopsy techniques. For example, these procedures often don't need the use of anaesthesia or sutures, and the donor site heals more quickly, at least at first. Diode lasers, KTP lasers, CO2 lasers, Nd: YAG lasers, and Er: YAG lasers are the lasers that are used for this purpose the most frequently.

Erythroplakia– Erythroplakia is treated with excision, which involves tracing the lesion with a pulsed carbon diode laser. The deeper tissues may also be impacted by the dysplastic alterations that take place in the epithelium. Therefore, the specimen also has to include the top part of the lamina propria. To avoid infiltration, many deep biopsy samples should be collected.

Oral Lichen Planus- Erosive lichen planus can be controlled by laser treatment. Carbon dioxide laser should be used along with selected local and systemic medications (Corticosteroids).

Oral Submucous Fibrosis- The use of a laser in the present period to remove fibrotic bands results in healing with less scarring, lowering the risk of procedure-induced trismus. Diode lasers are portable devices that transmit light across fibre optic cables, enabling them to reach locations that are typically "tough to-access." Because it only cuts deeper than 0.01 mm, tissues are preserved without harming deeper structures like muscles. So, even after substantial resection, laser treatment does away with the need for grafts to repair the defect. It produces fantastic functional outcomes.

Frictional Keratosis- Using a carbon dioxide laser with a 0.2mm spot size, little dubious lesions can be removed. The underlying tissues are then dissected with a laser beam at a little angle after the contour has been drawn using tissue forceps. It is simple to remove the lesion and have it examined by a pathologist. [6,7]

Smokeless Tobacco induced White lesions – After the habit is broken, these lesions can be healed. Sending the lesions for inspection should be done if they continue even after cessation, especially if they show ulceration. By employing the laser in a focused mode, they may be removed. They are often reachable by the laser that is located in the mandibular mucobuccal fold. [6,7]

Nicotinic Stomatitis - Laser therapy can be used to relieve any discomfort, burning, or ulceration the patient may be experiencing. To assist the patient in protecting the laser-treated surfaces while eating and drinking, a palatal splint is created. The carbon dioxide laser can be utilised similarly to a Nd: YAG contact round surgical probe. [7,8]

3. Recurrent Aphthous ulcer- Low Level Laser Therapy (LLLT) has recently been employed. It hastens wound healing and aids in the immediate alleviation of pain. Seventy-five percent of patients said they had great pain alleviation immediately following laser therapy, and the lesion completely disappeared four days later. [9] In addition, Bladowski et al. discovered that using a diode laser at low levels can cut the time it takes for a wound to heal in half when compared to using medication. [10]

The laser "passes" are separated by a time window of 15 to 20 seconds to allow the tissue to cool. To see if there is lessened discomfort, the region is massaged with a damp gloved finger. Similar to that, two further passes are necessary to totally alleviate the discomfort. After each pass, the area should be palpated to check for reduced pain. It is believed that this laser treated area is less likely to reappear with a new lesion, if treated 1-2 times.[8]

4. Herpes simplex virus infection– Various lasers wavelengths have been found to be effective in treating these lesions including HeNe laser(660nm) and Erbium:YAG laser(2940nm). The patients with secondarily infected lesions needed more than 48 hours to cure, although not more than 5 days.

5. Pigmented and vascular lesions - The treatment of cutaneous pigmented and vascular lesions is now safe and effective thanks to advancements in laser technique technology that enable variable spot sizes, different wavelengths, and a variety of efficient cooling devices. This is achieved by targeting specific chromophores while minimising damage to the surrounding tissue. Different wavelength lasers, such as the KTP (532 nm), pulsed dye (585-595 nm), and the Nd:YAG (1064 nm) laser systems, are used to treat vascular lesions. Because melanin absorbs light throughout a wide spectrum, pigmented lesions can be treated with a wide range of lasers. With its many customizable settings, intense pulsed light (IPL) has established itself as a helpful adjuvant for the treatment of a range of pigmented and vascular lesions.[11]

6. Benign Neoplasms– Keratoacanthoma -In addition to possible regional lymphadenopathy, the lesion is frequently uncomfortable. With a carbon dioxide laser, the lesion can be removed. This is accomplished by only slightly scarring the tissue. A circle is drawn around the lesion using the pulsed mode of the laser. A full thickness wedge is then eliminated by aiming the laser perpendicular to the outline boundary. The tissues might be approximated using sutures when it is removed.[6,7]

Oral papillomatosis- The mucosa has a papillary surface and is erythematous. A carbon dioxide laser or a Nd:YAG contact laser can be used to treat it. The first to use a carbon dioxide laser to remove this lesion was Sachs and Borden. After targeted punch biopsies have been collected, diffuse lesions can be treated using CO2 laser vaporisation. The lesion area is covered using the cross hatching technique while the laser is

in continuous defocus mode. [12] By stroking the surface in a similar cross-hatched pattern without raising the tip of the probe from the lesion's surface, the contact Nd:YAG laser may similarly be utilised to remove the lesion.[8]

7. Orofacial Pain– Trigeminal Neuralgia: Low-level laser therapy may be used to treat this condition. Without causing any negative effects, lasers can relieve pain. It could be beneficial, especially for people with neuralgia who can tolerate medication treatment.[13]

Myofascial Pain- Low-level laser therapy on MPDS patients' trigger sites necessitates a regular and exact schedule, and finishing the course of treatment is essential to seeing improvement. Low-level laser therapy decreases discomfort and tenderness in MPDS patients' masticatory muscles; however, etiologic variables must be eliminated in order to sustain these therapeutic results. Patients with MPDS who get low-level laser treatment cannot, on their own, get rid of their limited TMJ motions and joint noise. It is advised to use other suitable therapies concurrently.[14]

TMJ Disorders- According to this application, LLLT is a suitable therapy for discomfort associated with TMD and restricted mouth opening. Many alternative therapies have been utilised to treat TMD, including acupuncture, transcutaneous electrical nerve stimulation (TENS), massage, ultrasound, medication, occlusal splints, and psychiatric therapies. However, LLLT is a non-invasive, non-drug therapy that is well tolerated. It is a quick procedure that saves both the physician and the patient time, and the patient feels the effects right away. [15]

8. Salivary Gland Pathologies– Sialolithiasis –Depending on the gland affected and the location of the stone, there are numerous therapeutic options for salivary stones. minimally harmful A good alternative to traditional surgical salivary stone removal is Er:YAG laser-assisted surgery. [16] Large and challenging calculi can be removed with the Ho:YAG laser without having to remove the gland.[17]

Sialadenitis- The diode laser's haemostatic qualities allow for improved surgical field control and quicker healing of wound lesions. Er:YAG lasers' bactericidal impact has been demonstrated to lower infection and inflammation for improved wound healing. For the treatment of acute sialadenitis, a combination laser therapy using diode and Er:YAG lasers is advised.[18]

Mucocele- Mucoceles can be removed with laser therapy. Using Laser HF, the mucocele can be unroofed and the gland tissue removed along with it. High frequency technology, used by this laser, aids in precise cutting and lowers the danger of necrosis. Using the fibroma removal option, the lesion is removed (975nm, continuous wave). A defocused laser seals the edges of the incision without any negative consequences or problems. About three weeks are needed for re-epithelialization.[7]

9. **Treatment of abscess, cyst or granuloma-** Granulomas, abscesses, and cysts are common apical lesions that result from persistent root canal infection. These cystic lesions may grow and develop asymptotically. High-powered heat produced by these lasers kills infectious germs. However, some research revealed that sodium hypochlorite irrigation was more successful at killing microorganisms than diode laser irrigation.[19]

11. **Epulis and Irritation fibroma-** Large oral fibrotic lesions have been treated more effectively with lasers than with other methods, with a bloodless surgical site and no postoperative complications. It uses a safe and reasonably easy technique called a diode laser. A clean, thin, and quick cut is made possible by the simple handling of the fiberoptic tip in conjunction with the characteristics of the diode laser, frequently without bleeding or scarring. Due to the laser's sterilising and tissue-growth-promoting abilities, good recovery can be attained in a few days even without the use of surgical sutures.[20]

9. **Gingivectomy / Crown lengthening-** Gingivectomy is the most common procedure performed with dental lasers. All laser wavelengths can be used to precisely incise gingiva for restorative, cosmetic, and periodontal indications. Rapid healing and reduced pain are commonly seen post operatively and patients rarely need periodontal packing or sutures.

10. **Frenectomy or Ankyloglossia-** According to this application, LLLT can be used to relieve discomfort from TMD and restricted mouth opening. TMD has been treated with a variety of techniques, including acupuncture, transcutaneous electrical nerve stimulation (TENS), massage, ultrasound, medication, occlusal splints, and psychological counselling. But LLLT is a non-pharmaceutical, non-invasive, and well-tolerated procedure. It has a quick impact that the patient may experience following application and is a time-saving strategy for both the therapist and the patient.[21]

11 **Vestibuloplasty-** Insufficient vestibular depth leads to poor plaque management because there is not enough keratinized gingiva in the area. Vestibuloplasty, which can be carried out with a scalpel, electrocautery, or lasers, gives the required vestibular depth.[22] Compared to knife surgery, laser therapy's accelerated tissue healing reduces the amount of time needed for prosthesis rehabilitation.

Hard tissue applications:

1. **Root end resection / Apicoectomy-** Apicoectomy with retrograde filling is a well-known surgical technique for treating teeth with periapical lesions that persist. The apical root end is often removed using burs, and the surrounding periapical tissue is cured, however ultrasound or laser therapy are other options. The erbium laser, which is utilised for apicoectomy, has a significant positive impact on both the clinical outcome and therapeutic outcome. [22]

2. **Bracket curing-** Many advantages of argon lasers have been reported, including high-speed orthodontic adhesive curing and less enamel demineralization. Bond strength for argon laser curing is comparable to conventional light curing and is sufficient for clinical applications. Although the argon laser left more adhesive on the tooth surfaces on debonding, there was no increase in enamel surface fractures.[23]

3. **Removal of caries in deciduous and permanent teeth -** Traditional mechanical drilling procedures, together with the noise, vibration, and discomfort they cause, can make patients anxious and phobic about going to the dentist, especially if they are young. Dental discomfort, worry, and dread may be reduced by using more conservative and non-traumatic excavation equipment and procedures like laser. There isn't enough research to say if using a laser to remove caries is more or less effective than using a conventional mechanical approach.[24]

4. **Bleaching**— Although both laser-assisted and power bleaching methods may affect tooth colour, laser bleaching was shown to be more effective in this aspect. Several advantages of laser teeth whitening Application only takes 15 to 60 minutes, and the procedure only requires two to four sessions. When combined with a bleaching chemical, diode laser can be regarded as an effective therapy option for bleaching. The outcomes might be achieved in less time, which could result in higher patient compliance and satisfaction.[25]

5. **Etching of the tooth-** For direct bonding, 2.5W laser irradiation and phosphoric-acid etching are said to be almost equivalent. On the other hand, etching with phosphoric acid results in enamel demineralization and changes to the mineral composition of enamel tissues, which raises the risk of tooth decay. The laser-ablated surfaces exhibit crater development up close. In the Er:Yag laser, these craters are higher. For the surface modifications exhibited in the Nd:YAG laser-etched enamel, which result in a rough porous surface, it is noted that the acid-etched surfaces exhibit many micro gaps. [26]

6. **Smile design-** Restorative dentistry must work to establish symmetrical and harmonious interactions between the location of the natural dentate forms and the left gingival architecture in order to design the best possible outcome for a patient during aesthetic enhancement. Dental lasers make it possible to complete operations related to cosmetic and restorative dentistry in a way that is painless, less invasive, more precise, and far more efficient. It is simple to do gingival and/or recontouring to create an aesthetically pleasing and harmonious tissue profile. When a laser is utilised with quicker heating, patients often report less postoperative pain, increasing patient acceptability.[27]

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