

LASERS IN DENTISTRY

Dr. Arpita Srivastava^{1*}, Dr. Rahul Shrivastava², Dr. Rashi Srivastava³, Dr. Deepak Goel⁴, Dr. Rohit Kumar Khatri⁵, Dr. Setu Mathur⁶

1. MDS, Lecturer, Dept. of Oral Medicine & Radiology, Government College of Dentistry, Indore, M.P 2. MDS, Prosthodontics, Private Practitioner, Indore, M.P 3. Reader, Dept. of Oral Pathology, Rajasthan Dental College, Jaipur, 4. MDS, Assistant Professor, Dept. of Conservative Dentistry & Endodontics, RUHS College of Dental Sciences, Jaipur, 5. MDS, Assistant Professor, Dept. of Conservative Dentistry & Endodontics, RUHS College of Dental Sciences, Jaipur, MDS, Assistant Professor, Dept. of Periodontics, RUHS College of Dental Sciences, Jaipur

*Corresponding author – **DR ARPITA SRIVASTAVA**

Email id – khushi5s1@gmail.com

Received:15/11/2019

Revised:05/12/2019

Accepted:12/12/2019

ABSTRACT

The term LASER is an acronym for, “Light Amplification by the Stimulated Emission of Radiation”. Lasers are an important tool for dental treatment. They are used in dentistry since 1987. They are useful in treating hard and soft tissue lesions as their wavelength is ideally suited for both hard and soft tissue procedures. Laser technology has positively influence various branches of dentistry. With the help of lasers, dental treatments can be made less time consuming and more comfortable for the patients. There are various types of lasers available in the market. This article will explain the uses of laser in various fields of dentistry.

Key Words: Lasers, dentistry, wavelengths, dental applications

INTRODUCTION

The word LASER is an abbreviation for Light Amplification by Stimulated Emission of radiation. (1) The concept of lasers is based on Einstein’s theory of stimulated emission. (2) Lasers are used in a wide range of medical and cosmetic procedures. (3, 4) Recently it has received attention in clinical dental settings. With minimal anaesthesia lasers ablate the hard tissues. (5, 6) Bacterial counts in root canals are also reduced with the help of laser treatment. (7,8) During surgical procedure of soft tissues good hemostasis can also be achieved with their use. (9) The most common types are carbon dioxide (CO₂), diode, neodymium: yttrium–aluminum–garnet (Nd: YAG), and erbium: yttrium–aluminum–garnet (Er: YAG) lasers. They are used for cavity preparation, 5 tooth whitening, (10) gingival incisions, (11), and other applications. In

this article, I have reviewed the literature and the application of LASER in dentistry.

Classification of lasers in dentistry

Two categories of lasers are used in medicine and dentistry (13).

1. Hard tissue lasers
2. Soft tissue lasers or low-level lasers

Hard tissue lasers produce thermal effects which cut the tissue by coagulation, vaporization, and carbonization as they have a longer wavelength. Soft or low-level lasers provide cold thermal low energy wavelengths of less than about 450 nm with a minor temperature increase of less than 0.10°C. These wavelengths are believed to stimulate circulation and cellular activity.

Soft tissue lasers, which emits light in the visible or near-infrared region of the spectrum and causes

various effects such as anti-inflammatory, vascular, muscle relaxation, analgesia, and tissue healing also been attributed to them. Lasers most commonly used for low-level laser therapy are Helium-Neon (He-Ne) and Gallium Aluminum Arsenide (Ga Al As) lasers. Clinically low level or low intensity (LILT) laser therapy have been used to promote wound healing, reduce inflammation, edema and pain, localized osteitis, aphthous ulcers, herpes, dentinal hypersensitivity, temporomandibular disorders and more recently for diagnostic purposes.

How does a laser work (12)

A laser is a device, which excites atoms, the smallest particles of the Universe so that they give out energy as light in a special way. This occurs, using Theodore Maiman's rod made of ruby crystals. This rod is set inside a cylinder with a mirror at either end. One mirror is fully reflective, but the other is only partially silvered and so a very strong light will be able to pass through it. A flash tube is coiled around the cylinder. A tiny burst of light called photons is produced when the ruby atoms get excited by the flash of light and these photons strike the atoms to produce more photons until the tube is filled with photons. This results in bouncing back of photons from mirror to mirror forming laser beam.

Uses of lasers in dentistry

Diagnosis:

Early detection of pre-malignant lesions and malignant tumors may reduce patient morbidity and mortality because treatment at a less invasive stage is more successful, and therefore is of great clinical importance. The recent diagnostic procedure includes biopsy. The drawback with biopsy is the risk of under-diagnosis due to difficulty in determining the location leading to repeated biopsies which delay the treatment and it is also an invasive procedure. Auto fluorescence and diffuse reflectance spectroscopy are the non-invasive procedure for the detection of premalignant tissues. They can detect changes in tissue based on their tissue scattering and absorption properties. (15)

Gingiva and periodontium

Cobb et al (1992), 16 performed Nd: YAG laser irradiation into periodontal pockets and examined the effects of root debridement using a power of 1.75–3.0 W (87.5–150 mJ/pulse, 20 Hz), either alone or in combination with manual instrumentation. There was ineffective and patchy removal of calculus from the root surface. They concluded that laser therapy should be followed by mechanical

debridement. DNA probe analysis was used to confirm a decreased number of bacteria in periodontal pockets after laser treatment.

Henry et al (1995), (17) reported that the argon laser at a low level has a bactericidal effect on the *Prevotella* and *Porphyromonas* species in the presence of oxygen. They reported that low doses of argon laser radiation may be effective for the treatment of periodontal pocket.

The newly invented laser known as Waterlase performs scaling and root planning which involves hydrokinetic energy. The spray of atomized water with laser energy requires fewer dental appointments. They have other advantages like less need for anaesthesia, scalpels, and drills. They also disinfect gingival sulcus. (18)

PAIN

Arne Eckerdal (1996), (19) investigated a double-blind, placebo-controlled study to work out whether low reactive-level laser therapy (LLLT) is effective for the treatment of tic douloureux. The patients were treated with two probes. He reported that LLLT treatment is an efficient method and a superb supplement to standard therapies utilized in the treatment of tic douloureux.

Aphthous ulcers are one of the common causes of oral discomfort. (33) The clinician can easily treat the ulcer expeditiously and alleviate the patient's discomfort in a relatively short period of time using the laser. (20,21)

Most patients, experience dissipation of the lesion within 1 to 2 days. (20,22) For some it may take a week to resolve completely. One of the most remarkable advantages of using the laser in treating the ulcer is, the ulcer will not return to the same area. (20,22,23)

Didier Cowen (1997), 24 evaluated the efficiency of Helium-Neon (He-Ne) laser in the prevention of oral mucositis. He concluded that He-Ne laser treatment was well tolerated and it reduced high dose chemoradiotherapy induced oral mucositis.

INFECTION

HPV INFECTION

HPV lesions are multiple small cauliflower-like papillary projections usually found on the lips. These lesions require treatment since it has high correlation with oral squamous cell carcinoma. Total excisional laser biopsies have been treated successfully HPV lesions. Lasers have the hemostatic ability and provide bloodless surgical sites for HIV-positive

patients as they are at an increased risk of postoperative bleeding. Another benefit laser has when been used as biopsy instruments lies in their bactericidal effect. (25)

Masato Nagayoshi (2011), (26) reported the antimicrobial effects of diode laser irradiation on endodontic pathogens in periapical lesions. The results suggested that periapical lesions were treated with diode laser in combination with a photosensitizer by reducing the viability of microorganisms in the lesions.

ORAL SURGERY

Many different laser wavelengths have been used in the field of oral and maxillofacial surgery with many advantages of high coagulation properties, the incision quality, and postoperative benefits for the surgeon and the patient. Like the CO2 laser, which is the most used and accepted alternative method to conventional techniques to the surgical blade, other laser types (the Nd: YAG, the argon, the dye, the Ho: YAG, the Er: YAG and the diodes) can also be used effectively. Because of their selective physical properties, the Nd: YAG, the argon, the dye, can be applied especially for the removal of vascular lesions. Ho: YAG is the main surgical tool for the temporal mandibular joint surgery. (27)

N. Kalavathy, Sridevi (2010), (28) described a case of epulis fissuratum caused by an ill-fitting denture which was surgically excised by carbon dioxide laser and subsequent rehabilitation was done with new adequately fitting dentures.

Jorge Ocampo-Candiani (2003), (29) evaluated CO2 super pulsed laser treatment for Fordyce spots. They reported that CO2 super pulsed laser can be considered a safe and effective treatment for patients with Fordyce spots, it also gives excellent cosmetic results.

Many treatment techniques have been described for Pyogenic Granuloma. The treatment of choice is Excisional surgery. There are some recent advances such as the use of Nd: YAG laser, CO2 laser, flash lamp pulsed dye laser which are also successful in treating pyogenic granuloma. (30)

Jochen A. Werner (2001), (31) reviewed the published data on oncologic laser surgery for the treatment of head and neck carcinomas. They concluded that lasers may play a larger role in the management of head and neck cancers.

Premalignant and malignant lesions

T.C. Kok (2001), (32) assessed symptoms related to oral lichen planus (aLP), and lichenoid lesions (aLL) were relieved using CO2 laser. He concluded in his study that the utilization of CO2 laser for the treatment of aLP showed positive results.

Vasavi Krishnamurthy (2009), (33) evaluated the efficacy, safety, and therefore the acceptability of the CO2 laser for the management of oral leukoplakia and secondly, evaluated the character of post-operative adverse effects, if any, related to laser ablation. Six patients with Oral Leukoplakia were treated with CO2 laser Ablation. Patients tolerated the procedure well and complained of little pain initially. Healing occurred via secondary intention of the oral mucosal patches progressed well. Immediately after treatment, a carbonized layer formed on the wound surface. The dressing wasn't applied and therefore the areas were left exposed within the mouth. After 24 hours, a fibrinous coagulum had formed on the surface with little swelling and inflammation of the adjacent tissues. Mild pain, the swelling was experienced which peaked between 72 hours and 1 week. The patients were recalled after a period of two months. Little or no post-operative scarring and wound contraction was observed on healing. Thus, CO2 laser offers several advantages over conventional surgical methods and combines positive attributes of other techniques both as a bloodless scalpel and a way of destroying tissue with little postoperative morbidity to the patient.

Advantages and disadvantages of dental lasers(34)

One of the main benefits of using lasers in dentistry is that it selectively and accurately interplays with diseased tissues. In the surgical field laser reduces the amount of bacteria and other pathogens, it achieves good hemostasis in case of soft tissue procedures and at the same time avoids the need of sutures.

Cariou lesions can be removed with a hard tissue laser device as it contains more water which is the primary absorber of hard tissue laser wavelength.

There are some drawbacks to the current dental laser equipment. They are relatively expensive and require expertise. Modification of the technique is required sometimes because of the shape of the tips of the laser. Other disadvantages of laser are, they can produce air embolism due to excessive pressure of the air and water spray. It is sometimes difficult to

access the surgical area with the existing delivery system.

CONCLUSION

Lasers have become a ray of hope in dentistry. Lasers have quickly become indispensable in treatment modality for soft tissue surgery. Many new laser systems are on the market today, each with wavelengths and features that make them unique. Although these new systems make some procedures

easier, it has become essential for the laser surgeon to rely on the basic principles of laser physics to use them in a safe and efficient manner. Advances in laser technology undoubtedly will yield new procedures and have a major role in the future of minimally invasive treatments. But laser has got its own limitations. However, the future of dental laser is bright with some of the newest ongoing researchers.

Table: CHARACTERISTICS OF LASER USED IN DENTISTRY: (14, 1)

Laser Type	Common Abbreviation	Wavelength	Waveform	Delivery Tip	Clinical Applications
Carbon dioxide	CO ₂	10.6 μm	Gated or Continuous	Hollow waveguide beam focused when 1 to 2 mm from a target surface	Removes soft tissue lesions.
Neodymium: yttrium aluminum-garnet	Nd:YAG	1.064 μm	Pulsed	Flexible fiber optic system of varying diameters; surface contact required for most procedures	Soft tissue incision and ablation; subgingival curettage and bacterial elimination
Holmium: yttrium aluminum-garnet	Ho:YAG	2.1 μm	Pulsed	Flexible fiber optic system; surface contact required for most procedures	Soft tissue incision and ablation; subgingival curettage and bacterial elimination
Erbium: yttrium aluminum-garnet	Er:YAG	2.94 μm	Free-running pulsed	Flexible fiber optic system or hollow waveguide; surface contact required for most procedures	Soft tissue incision and ablation; subgingival curettage; scaling of root surfaces; osteoplasty and ostectomy
Erbium, chromium: yttrium selenium gallium garnet	Er,Cr:YSGG	2.78 μm	Free-running pulsed	Sapphire crystal inserts of varying diameters; surface contact required for most procedures	Dental caries removal, Soft tissue incision, and ablation; subgingival curettage; osteoplasty and ostectomy
Neodymium: yttrium aluminum-perovskite	Nd:YAP	1,340 nm	Pulsed	Flexible fiber optic system; surface contact required for most procedures	Soft tissue incision and ablation; subgingival curettage and bacterial elimination
Indium-gallium arsenide-phosphide; gallium aluminum arsenide; gallium arsenide	InGaAsP (diode) GaAlAs (diode) GaAs (diode)	Diodes can range from 635 to 950nm	Gated or Continuous	Flexible fiber optic system; surface contact required for most procedures	Soft tissue incision and ablation; subgingival curettage and bacterial elimination

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How to cite this article: Lasers in dentistry, Srivastava A., Shrivastava R., Srivastava R., Goel D., Khatri R.K., Mathur S.. *Int.J.Med.Sci.Educ* 2019;6(4):99-104