Review Article

Dental Lasers: The Clinical Applications

Soumya Joseph*, Charan Teja Bobba[1]

1. BDS, GSL Dental College and Hospital, Andhra Pradesh, India.

***Corresponding Author: Soumya Joseph,** BDS, AECS Maaruti College of Dental Sciences and Research Center, Bengaluru, India.

Received Date: October 31, 2020

Publication Date: December 01, 2020

Abstract

The term LASER is an acronym for 'Light Amplification by the Stimulated Emission of Radiation". Lasers can be used for a wide variety of applications in dentistry. These have an important role to play in hard as well as soft tissue surgical procedures. In the last two decades, there has been an explosion of research studies of laser application in dentistry. In this review article, the clinical application of lasers has been discussed.

Keywords: *Dental Lasers, Soft Tissue Lasers, Hard Tissue Lasers*

Introduction

The term LASER is an acronym for 'Light Amplification by the Stimulated Emission of Radiation". Lasers can be used for a wide variety of applications in dentistry. These have an important role to play in hard as well as soft tissue surgical procedures. In the last two decades, there has been an explosion of research studies of laser application in dentistry. In this review article, the clinical application of lasers has been discussed.

Lasers used in dental practice can be classified by various methods: a. According to the lasing medium used; gas laser and solid laser; b. according to tissue applicability; hard tissue and soft tissue lasers; c. according to the range of wavelengths. In dental lasers, the laser light is delivered from the laser to the target tissue via a fiberoptic cable, hollow waveguide, or articulated arm. Focusing lenses, a cooling system, and other controls complete the system**(**1**)**. The wavelength and other properties of the laser are determined primarily by the composition of an active medium, which can be a gas, a crystal, or a solid-state semiconductor.

The dental lasers in common use today are Erbium, Nd: YAG, Diode, and CO2. Each type of laser has specific biological effects and procedures associated with them. A solid understanding of each of these categories of devices is imperative for any clinician hoping to pursue laser use in their practice. In the following section some commonly used lasers are briefly described:

CO_2 Laser

The CO_2 laser wavelength has a very high affinity for water, resulting in rapid soft tissue removal and hemostasis with a very shallow depth of penetration. Although it possesses the highest absorbance of any laser, disadvantages of the CO_2 laser are its relatively large size and high cost and hard tissue destructive interactions.

Nd: YAG Laser

It is highly absorbed by the pigmented tissue, making it a very effective surgical laser for cutting and coagulating dental soft tissues, with good hemostasis. In addition to its surgical applications **(**2**)**, this type of laser has also been used for nonsurgical sulcular debridement in periodontal diseases.**(**3**)**

Erbium Laser

The erbium wavelengths have a high affinity for hydroxyapatite and the highest absorption of water in any dental laser wavelengths. Consequently, it is the laser of choice for the treatment of dental hard tissues.**(**4**)** This can be used for cavity preparation and access opening.

In addition to hard-tissue procedures, erbium lasers can also be used for soft tissue ablation, because the dental soft tissue also contains a high percentage of water.

Diode Laser

All diode wavelengths are absorbed primarily by tissue pigment (melanin) and hemoglobin. Specific procedures that could be performed by diode lasers which include aesthetic gingival re-contouring, soft tissue crown lengthening, exposure of soft tissue impacted teeth, removal of inflamed and hypertrophic tissue, frenectomies, and photostimulation of the apthous and herpetic lesions. **(**5**)**.

Clinical Applications of Lasers in Dentistry

Lasers can be used for a wide variety of procedures in dentistry including both hard as well as soft tissue procedures. In the following sections, soft tissue and hard tissue applications of lasers in the dental field are discussed.

Soft Tissue Application

Laser dentistry and soft-tissue surgery, in particular, have become widely adopted in recent years. Significant cost reductions for dental lasers and the increasing popularity of CAD/CAM, among other factors, have contributed to a substantial increase in the installed base of dental lasers, especially soft-tissue lasers. New development in soft-tissue surgery, based on the modern understanding of laser-tissue interactions and contact soft-tissue surgery mechanisms, will bring a higher quality and consistency level to laser soft-tissue surgery. Recently introduced diode-laser technology enables enhanced control of side effects that result from tissue overheating and may improve soft-tissue surgical outcomes.

Aesthetic gingival re-contouring and crown lengthening

With the advent of the diode laser, gingival contouring has become easy and that too bloodless now. Clinicians prefer to do it for orthodontic patients as well, who have gingival enlargements. The diode lasers have also been widely used for crown lengthening procedures.

Exposure of unerupted and partially erupted teeth

By the use of a dental laser, an impacted or partially erupted tooth can be exposed for bonding by conservative tissue removal, allowing for reasonable positioning of a bracket or button. It has the advantage of no bleeding, and an attachment can be placed immediately, and it is not painful at all.

Frenectomies

The frenum is a highly vascular area, so during surgical excision of the frenum, there is severe bleeding which usually takes some time to stop. But with the use of dental lasers, this procedure has become very simple, because the laser also reduces the bleeding due to its coagulation effects. Frenectomies performed with a laser permit excision of the frena painlessly, without bleeding, sutures, or surgical packing, and with no need for special postoperative care. Now the frenum removal has become simple, painless and bloodless.

Laser Biopsy

All dental laser wavelengths are capable of performing precise biopsies. Smaller lesions can often be removed with a compounded topical anaesthetic only. Sutures are rarely needed due to the excellent hemostasis and minimal trauma observed when lasers are used properly. Any lesion removed needs to be submitted to an oral pathologist for microscopic diagnosis. The dentist should also note what type of laser was used as there is often a tissue effect visible along the incision known as a “laser artifact”. The artifact varies depending on the thermal effects of the particular laser and settings used.

Hard Tissue Applications

Cavity preparation

Hard tissue laser (Erbium YAG) can be used for cavity preparation of teeth. The major advantage of using lasers in these cases is that there is no need for anaesthesia, no sound is produced and drilling is not required. Patients who are not comfortable with the sounds of handpieces can be treated with lasers.

Access Opening in Endodontics

Lasers can also be used for access opening for endodontic treatment of teeth. The procedures are technique sensitive and should be performed with great caution. Studies have shown that successful endodontic treatments can be performed with lasers.

Miscellaneous Uses of Lasers

Wound healing

Low-level laser treatment (LLLT) of gingival fibroblasts in the culture has been shown to induce transformation in myofibroblasts (useful in wound contraction) as early as 24 hours after laser treatment. **(**6**)** The positive effects of LLLT on the healing of lesions of recurrent aphthous stomatitis in humans have also been reported. It has also been reported that LLLT promotes healing and dentinogenesis following pulpotomy, as also the healing of mucositis and ulcerations.

Post Herpetic Neuralgia

Photo stimulation of aphthous ulcers and recurrent herpetic lesions, with low levels of laser energy, can provide pain relief and accelerate healing. **(**7**)** In the case of recurrent herpes simplex labialis lesions, photo stimulation during the prodromal (tingling) stage seems to arrested the lesions before painful vesicles form and accelerate the overall healing time.

Photoactivated dye disinfection (PAD)

Lasers have antimicrobial effects at specific wavelengths when these are used to photoactivate certain dyes. The major clinical applications of PAD include disinfection of root canals, periodontal pockets, deep carious lesions, and sites of peri-implantitis. **(**8**)** Tolonium chloride is used in high concentrations for screening patients, for malignancies of the oral mucosa and oropharynx.

Photodynamic therapy for malignancies

Photodynamic therapy (PDT), which has been employed in the treatment of malignancies of the oral mucosa, particularly multi-focal squamous cell carcinoma, acts on the same principle of PAD, and generates reactive oxygen species, which in turn, directly damages the cells and the associated blood vascular network, triggering both necrosis and apoptosis; **(**9**)** this activates the host immune response and promotes anti-tumour immunity through the activation of macrophages and T lymphocytes. There is direct evidence of the photodynamic activation of the production of the tumour necrosis factor, alpha, a key cytokine in host anti-tumour immune responses.

Analgesic effect of the laser

Various previous studies have also reported that dental lasers have an analgesic effect. These show that low-level laser therapy decreases the firing frequency of nociceptors (pain receptors). Some studies also claimed that successful analgesia can be achieved following oral surgical procedures by the use of low-level laser therapy. Local CO2 laser irradiation will reduce the pain associated with orthodontic force application, without interfering with tooth movement. **(**10**)**.

Nerve repair and regeneration

Low-level laser therapy has been seen to reduce the production of inflammatory mediators of the arachidonic acid family from injured nerves, and to promote neuronal maturation and regeneration following injury. In the dental field, positive results have been reported in the regeneration of inferior dental nerve tissue which was damaged during the lower molar impaction procedures. Though the data available on this aspect is limited, the result has been promising.

Post-surgical pain

A single episode of LLLT (irradiance 0.9-2.7 J) is 100% effective for apical periodontitis following root canal treatment and post-extraction pain. There are conflicting results about pain reduction post-extraction by LLLT versus placebo control.

Lasers in Pediatric Dentistry

Dental lasers offer many advantages when treating children. All procedures previously discussed apply to pediatric treatments as well. The ability to provide care with less use of needles and high-speed handpieces makes for a less traumatic experience. Behavioural management improves when these frightening devices are not used. Subsequent treatment appointments are often easier to manage as well when the child has a more positive experience. All previously discussed restorative and surgical procedures can be performed safely on children. Dental lasers can also aid in procedures such as pulpotomies and orthodontic surgical needs.

Laser Safety

Proper safety procedures must be put in place by any practice implementing laser use. A laser safety officer needs to be appointed by the clinic whose job it is to implement and monitor safety protocols. The manufacturer of each device is obliged to train the providers on the important safeguards needed for each device.

Common safety practices include:

• **Eye Protection** – The patient, clinical staff and any observers must wear protective eyewear specific for the wavelength being used.

• **Plume Control** – Laser procedures create a plume that may contain hazardous chemicals and microflora. Standard dental high-speed evacuation properly used is adequate to control the plume. Good quality masks need to be worn by the clinicians.

• **Sharps** – Scored laser tips of quartz fibers are considered sharps and need to be disposed of as such.

• **Warning Sign** – Warning signs need to be in a visible place and access to the operatory limited.

Conclusion

Dental lasers are now well-established instruments. Ongoing research is showing many benefits of laser therapy. The ability to perform less invasive procedures with greater patient comfort makes laser dentistry something the modern practitioner should consider. A thorough understanding of laser physics and biological effects is mandatory for any provider. Comprehensive beginner and ongoing training are imperative to use these devices effectively and safely.

References

1. Fujiyama K, Deguchi T, Murakami T, Fujii A, Kushima K, Takano-Yamamoto T. "Clinical effect of CO2 laser in reducing pain in orthodontics". Angle Orthod. 2008;78:299–30.

2. Fornaini C, Rocca JP, Bertrand MF, Merigo E, Nammour S, Vescovi P. "Nd: YAG and diode lasers in the surgical management of soft tissues related to orthodontic treatment". Photomed Laser Surg. 2007;25:381–92.

3. Aoki A, Mizutani K, Takasaki AA, Sasaki KM, Nagai S, Schwarz F, et al. "Current status of clinical laser applications in periodontal therapy". Gen Dent. 2008;56:674–87.

4. Harashima T, Kinoshita J, Kimura Y, Brugnera A, Zanin F, Pecora JD, et al. "Morphological comparative study on ablation of dental hard tissue at cavity preparation by Er: YAG and Er, CR: YSGG lasers". Photomed Laser Surg. 2005;23:52–5.

5. Hilgers JJ, Tracey SG. "Clinical uses of diode lasers in orthodontics". J Clin Orthod. 2004;38:266–73.

6. Pourreau-Schneider N, Ahmed A, Soudry M, Jacquemier J, Kopp F, Franquin JC, et al. "Helium-neon laser treatment transforms fibroblasts into myofibroblasts". Am J Pathol. 1990;137:171–8.

7. Olivi G, Genovese MD, Caprioglio C. “Evidence-based dentistry on laser paediatric dentistry”. Eur J Paediatr Dent. 2009;10:29–40.

8. Walsh LJ. “The current status of low level laser therapy in dentistry. Part 2. Hard tissue applications”. Aust Dent J. 1997;42:302–6.

9. Dougherty TJ. “An update on photodynamic therapy applications”. J Clin Laser Med Surg. 2002;20:3–7.

10. Mezawa S, Iwata K, Naito K, Kamogawa H. “The possible analgesic effect of soft-laser irradiation on heat nociceptors in the cat tongue”. Arch Oral Biol. 1988;33:693–4.

Volume 1 Issue 4 December 2020