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Application of laser in dentistry- A review

Milind Rajan[1], Sumeet Vincent Tigga[2], Jandel Singh Thakur[3], Sanmati S Varne[4], Aditi M Bulbule[5], Deepika Chandra[2]

[1] Post graduate student, Department of Pedodontics and preventive dentistry, Coorg institute of dental sciences, Virajpet, Karnataka, India

[2] MDS Orthodontics and Dentofacial orthopedics), Maitri College of Dentistry and Research Centre, Durg, Chhattisgarh, India

[3] Assistant Professor, Pt. Jawaharlal Nehru Memorial Medical College, Raipur, Chhattisgarh, India

[4] Post graduate student, Department of Prosthodontics and Implantology, Coorg Institute of Dental Sciences, Virajpet, Karnataka, India

[5] Senior lecturer, Department of pedodontics and Preventive Dentistry, SMBT Institute of Dental Sciences and Research, Nandihills, Dhamongaon-ghoti, Igatpuri, Nashik, Maharashtra, India

Abstract
The term LASER is an acronym for 'Light Amplification by the Stimulated Emission of Radiation'. As its first application in dentistry by Miaman, in 1960, the laser has seen various hard and soft tissue applications. Laser technology has been recently introduced into the dental field with the idea to replace drilling. Having a less painful first dental experience by the use of modern instruments like laser can be an efficient preventive and therapeutic measure in dentistry. It can be effectively used for caries detection and removal, vital pulp therapy, reducing the risk of infection, inflammation and to achieve hemostasis. On the other hand, due to minimal invasion, laser treatment is well accepted by children and anxious patients. This review of literature aimed to provide details of the available types of lasers and their applications in dentistry.

Keywords: laser, laser in dentistry, laser surgery

Introduction

The word LASER is an acronym which stands for light amplification by stimulated emission of radiation, and it was first introduced in an article in 1959 by Gordon Gould, a Columbia University graduate student [1]. Laser was first used for soft tissue incision; But, the new generation of lasers with their special function on water molecules can be used for ablation of dental hard tissue as well [2]. Commonly used laser in dentistry includes neodymium-yttrium aluminium garnet laser, erbium: yttrium aluminium garnet, CO2, erbium chromium: yttrium scandium gallium garnet, holmium: yttrium aluminum garnet, and diode laser [3]. Since contemporary dentistry is based upon the use of minimally invasive procedures, laser can serve as a favourable alternative to drilling due to having less pain, sound and vibration. Maintaining a dry environment enhances the clinician's view of the working area and results in a better outcome. Moreover, substitution of sharp dental instruments with laser attracts more patients to dental clinics [4]. It can be effectively used for caries detection and removal, vital pulp therapy, reducing the risk of infection, inflammation and to achieve hemostasis. On the other hand, due to minimal invasion, laser treatment is well accepted by children and anxious patients [5]. Present review of literature aimed to provide details of the available types of lasers and their applications in dentistry.

History of Laser [3, 5]

1. In May 16, 1960, laser was developed by Theodore Maiman using a synthetic ruby crystal.
2. 1%-3% neodymium was used with Yttrium-Aluminum-Garnet crystals for the production of Nd-YAG laser in 1961
3. In 1962, the argon laser was developed
4. The ruby laser became the first medical laser to coagulate retinal lesions, when it was used in 1963.
5. In 1964, Patel at Bell Laboratories developed the CO2 laser
6. In 1971, Weichman and Johnson reported the use of infrared CO2 laser for apical foramen sealing in a vitro study.

Classification of Laser [6]

Table 1: Classification of Laser

Based on active medium	Based on application	Based on wavelength
A. Solid B. Liquid C. Gas	A. Soft tissue lasers B. Hard Tissue lasers	A. Excimer - 195-350nm B. Alexandrite - 337nm C. Argon - 455-515nm D. He-Ne - 637nm E. Diode - 655-980nm F. Nd:YAG - 1064nm G. Ho:YAG - 2100nm H. Er, Cr:YSGG - 2780nm I. Er:YSGG - 2790nm J. Er:YAG - 2940nm K. CO2- 10600nm
Based on mode of operation		
A. Continuous B. Pulsed		

Application of laser in dentistry [7]

The rapid development of laser technology has seen its introduction into various fields of dentistry. Some of the present applications of laser in dentistry are as follows:

Table 2: Application of laser in dentistry

Diagnosis	Hard tissue applications	Soft tissue applications	Laser activation
1. Detection of pulp vitality 2. Detection of caries 3. (Laser fluorescence)	1. Caries removal and cavity preparation 2. Re-contouring of bone 3. Endodontics (root canal preparation, sterilization and apicectomy 4. Laser etching	1. Soft tissue curettage 2. Gingivectomy and Gingivoplasty 3. Coagulation 4. Tissue fusion 5. Pulp capping 6. Pulpotomy 7. Implant exposure	1. Composite resin 2. Bleaching agents

Soft Tissue application

Wound healing

At low doses (e.g., 2 J/cm2), laser application stimulates proliferation, while at high doses (e.g. 16 J/cm2) it is suppressive. It affects fibroblast maturation and locomotion, and this in turn may contribute to the higher tensile strengths reported for healed wounds. There are some positive data, which indicate that LLLT promotes healing and dentinogenesis following pulpotomy, as also help in the healing of mucositis and oropharyngeal ulcerations in patients undergoing radiotherapy for head and neck cancer [8].

Frenectomy and treatment of ankyloglossia

When hyperactive labial frenum is present, a laser assisted frenectomy could be done with Er: YAG laser in an attempt for diastema closure. Er: YAG laser is also used for surgical management of tongue tie or ankyloglossia in infants and children [9].

Pulpotomy of Primary tooth

Pratima B *et al* (2018) [10] evaluated the of diode laser zinc oxide eugenol and mineral trioxide aggregate pulpotomy procedures in children and found 100% clinical and radiographic success with diode laser MTA pulpotomy [10].

Laser in tooth bleaching

Bleaching gel contains peroxide which upon oxidation produces bleaching action. When laser light hits this bleaching gel, it produces heat and oxidation which accelerates the bleaching process [3].

Laser assisted pulp capping

CO_2 laser can be used for direct pulp capping as it controls haemorrhage and sterilizes the exposure site which facilitates better placement of calcium hydroxide paste at exposure site and induces favourable clinical outcome. The laser energy has an obtundant and sedative effect on inflamed pulpal tissue, and it can also close the dentinal tubule [11].

Exposure of unerupted and partially erupted teeth

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 moreover, it is not painful at all [12].

Hard Tissue application

Laser Etching

Laser etching has been evaluated as an alternative to acid etching of enamel and dentine. Enamel and dentine surfaces etched with (Er, Cr: YSGG) lasers show micro-irregularities and no smear layer. Adhesion to dental hard tissues after Er: YAG laser etching is inferior to that obtained after conventional acid etching [13].

Treatment of dentinal hypersensitivity

The laser assisted treatment of dentinal hypersensitivity is a good method to solve immediate and long term pain. As compared to topical desensitizing agents, laser treatment provide rapid and long term relief from dentinal sensitivity [14].

Pit and fissure sealants

Laser can be used for fissurotomy, cleaning, and conditioning of pits and fissures before sealant application. Erbium laser is mostly used for fissurotomy procedure [15].

Cavity preparation, caries, and restoration removal

Various studies illustrate the use of Er: YAG, since 1988, for removing caries in the enamel and dentine by ablation, without the detrimental effect of rise in temperature on the pulp, even without water-cooling, with low '*fluences*' laser (LLLT), similar to air-rotor devices, except that the floor of the cavity is not as smooth. The Er: YAG laser is also capable of removing composite resin, and glass ionomer cement from old rstorations [16, 17].

Advantage of Laser [6]

1. No anesthesia, no drill
2. Less blood loss, less pain, hemostatic and analgesic effect
3. Reduce post-operative edema
4. Less post-operative scarring
5. Sterilization of treatment site
6. Laser exposure to tooth enamel causes reduction in caries activity
7. Patient becomes free of fear and anxiety
8. Advantageous for medically compromised patients

Disadvantage of Laser [6]

1. Laser beam could harm the patient or operator by direct beam or reflected light, causing retinal burns
2. More expensive
3. Need qualified personal
4. Lasers can't be used to remove defective crowns or silver fillings.

Conclusion

Laser can be a suitable alternative for many conventional dental procedures including diagnosis, removal of caries, pulp therapy, decreasing the risk of infection, reducing bleeding, enhancing soft tissue healing, pain relief and reducing gag reflex. A further area of future growth is expected for combination of diagnostic and therapeutic laser techniques.

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