Review Article

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Lasers in Clinical Dentistry: An Overview

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Abstract

LASERS have become an integral part of dentistry. LASER is an acronym for 'Light Amplification by Stimulated Emission of Radiation'. Invention of LASER dates back to as early as 1917, when Albert Einstein put forward the theory of photoelectric amplification could emit a single frequency. The primary action of lasers on dental tissue is dependent on how well the chromophore (water, apatite minerals, pigmented substances, etc.) is absorbed by the laser tissue. Laser has various applications in endodontics, operative dentistry, periodontics, orthodontics, etc.

Keywords: Lasers; Dentistry; Mechanism; Endodontics; Prosthodontics; Orthodontics; Cosmetic Dentistry.

Introduction

LASERS have become an integral part of dentistry. LASER is an acronym for 'Light Amplification by Stimulated Emission of Radiation'. The seeds of invention of LASER were laid as early as 1917 by Albert Einstein when he postulated the theory of stimulated emission.[1] It was as late as 1971 that LASERS were introduced in dentistry.[2] Now a days, with advancing technology, LASERS have found their application in almost all branches of dentistry. LASERS can broadly be divided into hard lasers like Carbon dioxide (CO_2), Neodymium Yttrium Aluminum Garnet (Nd: YAG), and Er: YAG. The others are cold or soft lasers, which will be explained in detail.[3,4] The aim of this review paper is to give an overview of LASERS in dentistry, their application and safety concerns.

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HISTORY

Invention of LASER dates back to as early as 1917, when Albert Einstein put forward the theory of photoelectric amplification could emit a single frequency. It was introduced to the general public by Gordon Gould who was a Columbia University graduate student.[5] the first functioning laser was built by Theodore Malibu, CA.[6] Later in 1962, argon laser was developed. Ruby laser began to be used in Opthalmolology for retinal lesions. Patel Bell Laboratories developed the CO2 laser.[5]

In dentistry, Hibst and Paghdiwala first described the effect of Er:YAG laser on dental hard tissues.[7] but due to concerns of safety, it was approved by the US FDA for cavity preparation

One of the earliest companies to release Er:YAG lasers onto the market was KaVo (Germany) in

1992. The recent rapid development of lasers, with different wavelengths and onboard parameters may continue to have major impact on the scope and practice of dentistry.

MECHANISM OF ACTION OF LASERS IN DENTISTRY

The primary action of lasers on dental tissue is dependent on how well the chromophore (water, apatite minerals, pigmented substances, etc.) is absorbed by the laser tissue. Central to this is the photothermal mechanism.[8]

Mechanisms of laser action can be simplified as:

1. Photo-thermal ablation: Majorly occurs with high powered lasers, when used to vaporization or coagulate tissue through absorption in a major tissue component
2. Photo-mechanical ablation: Shock wave formation, Cavitations etc. causing disruption of tissue due to a range of phenomena
3. Photo-chemical effects [9-11] Using light sensitive substances to treat conditions such as cancer.

Factors that influence the nature of the effect of lasers on tissue comprise the laser variables of wavelength, pulse energy or power output, exposure time, spot size (and thus energy density), and the tissue variables of physical and chemical composition (e.g. water content, density, thermal conductivity and thermal relaxation).[12]

CLASSSIFICATION OF TYPES OF LASERS

LASERS in dentistry can be classified as:

1. According to the lasing medium used: Gas laser and solid laser.
2. According to tissue applicability, hard tissue and soft tissue lasers.
3. According to the range of wavelength and risk associated with laser use.[13]

Application of Lasers in Dentistry

For ease of understanding the application in dentistry can be divided as:

Diagnosis

Detection of pulp vitality

- Doppler flow metry
- Low level laser therapy (LLLT)

Laser Doppler flow metry was developed measuring blood flow in dental pulp.it uses low power of 1 or milli watt from helium-neon and diode laser.[14]

Application of Laser in Endodontics

The clinical application of low-intensity laser in endodontic therapy has been considered useful in post pulpotomy (with the laser beam applied directly to the remaining pulp and on the mucosa toward the root canal pulp); post pulpectomy (with the irradiation of the apical region); periapical surgery (irradiating the mucosa of the area corresponding to the apical lesion and the sutures). For intracanal application, a fiber supported laser delivery system having appropriate diameter is required which is capable of delivering laser energy laterally.[15] In addition, disinfection will be achieved in contaminated root canals due to the bactericidal effect of thermal interaction.[16]

Application of Laser in Periodontics

Depending on absorption characteristics, mode of action and indications various lasers can be used in procedure such as gingivectomy, gingivoplasty, scaling and root planning. Usually Er; YAG, Nd;YAG , CO_2 laser is used in removal of hyperplastic gingival tissues, as it is characterized by least post operative pain, absence of scarring etc.[16,17] Laser gingivectomy with Er: YAG laser is suitable for immunocompromised patients as it exhibits excellent anti bacterial effects. It is also used to remove concrement and plaque from root surface along with sufficient water cooling. While comparing lasers with conventional periodontal surgical procedures, reduction in plaque index, bleeding index, pocket depth and better reattachment was observed.

Application of Laser in Orthodontics

The application of lasers in orthodontics depends upon potential advantage of lasers over conventional methods.[18] Classical methods of acid etching imply use of phosphoric acid (37%) as a gel or solution on the enamel surface. The time of action is of 15-60 seconds. The enamel appears matt, after washing and drying. The use of CO_2, Nd;YAG, Er; YAG lasers is an alternative for enamel conditioning and has proved to be more effective than phosphoric acid. For laser etching the surface must be covered with accelerator and area will be irradiated until evaporation of accelerator. For esthetic reasons ceramic brackets are very frequently used in orthodontic treatment

but when these brackets are detached from teeth it can cause enamel fractures, thus can be avoided by thermal detaching of brackets by CO_2 and YAG lasers. Strobl and Tocchio presented the data about changes occurred during detaching of brackets with CO2, YAG lasers.[19] Studies also suggest that Er;YAG lasers are widely used for enamel surface conditioning.[20]

Application of Lasers in Cosmetic Dentistry

Tooth discolouration is the change in colour of teeth as compared with adjacent teeth; it may be due to genetic malformation or genetic disorders. Bleaching of discoloured teeth has decreased need for invasive treatment. Bleaching is a chemical whitening teeth in which hydrogen peroxide, sodium perborate, chlorine etc are used. In office bleaching techniques may involve use of energy sources to increase rate of release of bleaching radicals. Different lasers produce different wavelengths, hence not all lasers are suitable for bleaching. Wave length absorbed, scattered or transmitted TA

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