Review Article

Imperative role of Lasers in perspective future dental research and advancements: An Insight story

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ABSTRACT:
Laser is one of the latest technologies which promise the dentist and patient to deliver superior quality of dentistry. The advantages of laser dentistry over conventional approach are several e.g minimal bleeding, surgeries with no or minimal use of anesthesia, tooth preparations without creating micro fractures etc. This article highlights different types of lasers used in dentistry with mechanism of action especially emphasizing on the use of lasers in Prosthodontics, its advantages, disadvantages and limitations. This article is an attempt to create more awareness about lasers amongst clinicians and to make use of it for better practice. The continued development of laser technology may lead in creating a different branch in dentistry "Lasers Dentistry".
Key Words: *Lasers, Laser Dentistry, Dental research.*

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INTRODUCTION: In the present era clinicians are keenly searching for better techniques, instruments and materials that allow the delivery of superior dental treatment with better patient comfort. Technologies like CAD-CAM restorations, digital radiography and photography, implantology, maxillofacial dentistry, etc are gaining tremendous amount of popularity by providing an efficient and beneficial alternative over the conventional dentistry. The use of lasers is one of these hallmark technologies that enables dentist to work faster, more precisely and more efficiently. Laser can be described as Light Amplification by Stimulated Emission of Radiation.

HISTORY

The use of laser in dentistry has been developed over the last three decades. Initially it was introduced as an alternative to traditional halogen curing light but now it has become the instrument of choice in many dental applications. In 1916 Albert Einstein postulated photons and stimulated emission and won the Nobel prize for related research on the photoelectric effect.[1] In 1956 American physicist Townes first amplified microwave frequencies by the stimulated emission process and the acronym MASER (Microwave Amplification by Stimulated Emission of Radiation) came into use.[2] Term laser was coined by GORDON GOULD in 1957 while in 1958, Schawlow and Townes discussed extending the MASER principle to the optical portion of the electromagnetic field. This became the principle of LASER4. In 1990, the FDA cleared for intra oral laser, a pulsed Neodymium:Ytrium – Aluminium, Garnet laser (Soft tissue laser) developed by

Myers and Myers, called "d lase 300".[3] On May 7, 1997 FDA approved Er:YAG laser, the first laser used for treating human dental cavities. It was reported to cause some damage to the tooth structure but currently available lasers are safer.[4]

LASERS USED IN DENTISTRY[5]

1. Argon ion laser (wavelength of 488 (blue) and 514 nm (blue green)
2. Carbon dioxide laser (10, 600 nm)
3. Diode laser (810, 940 and 980 nm, infra red spectrum)
4. Neodymium;ytrium-aluminium-Garnet laser (1064 nm, infra red)
5. Erbium; Ytrium-Aluminium-Garnet laser (2780, 2940 nm)
6. Holmium; ytrium-aluminium-Garnet laser (2100 nm)
7. Helium-Neon[He-Ne] laser (670 nm)

LASER COMPONENTS

Lasers are generically named for the material of the active medium, which can be a container of gas, a crystal or a solid state semiconductor. There are two mirrors, one at each end of optical cavity, placed parallel to each other. Surrounding the core is an excitation source, either a flash lamp device or a electrical coil, which provides the energy into the active medium. A cooling system, focusing lenses, and delivery system complete the mechanical components.[1]

There are two gaseous active medium lasers used in dentistry: Argon and carbon di oxide.[8] The remainders that are available are solid state semiconductors wafers made with multiple layers of metals such as Gallium and Aluminum. After the stimulation of active medium by the excitation source, the photons are amplified by the mirrors and emerge as laser light.

How does it work?

The principle effect of laser energy is photothermal (i.e., the conversion of light energy into heat). This thermal effect of laser energy on tissue depends on the degree of temperature rise and the corresponding reaction of the interstitial and intracellular water. The first event, hyperthermia, occurs when the tissue is elevated above normal temperature but is not destroyed. At temperatures of approximately 60°C, proteins begin to denature without any vaporization of the underlying tissue. The tissue whitens or blanches.[9] This phenomenon is useful in surgically removing diseased granulomatous tissue because if the tissue temperature can be controlled, the biologically healthy portion can remain intact. Soft tissue edges can be ''welded'' together with a uniform heating to 70ºC to 80ºC where there is adherence of the layers because of stickiness due to the collagen molecule's helical unfolding and intertwining with adjacent segments. When the target tissue containing water is elevated to a temperature of 100ºC, vaporization of the water within the tissue occurs, [6] a process also called "ablation". Because soft tissue is composed of a high percentage of water, excision of soft tissue commences at this temperature. The apatite crystals and other minerals in dental hard tissue are not ablated at this temperature, but the water component is vaporized, and the resulting jet of steam expands and then explodes the surrounding matter into small particles. This mixture of steam and solids is then suctioned away. This micro-explosion of the apatite crystal is termed ''spallation''.

Where to use what?

• Erbium (wavelength above 2700 nm) and CO2 wavelength are well absorbed by tissues with high water content.[4]

• Shorter wavelength (500-1100 nm) as Argon, Diode & Nd:YAG are well absorbed by blood component i.e Haemoglobin and tissue pigments like melanin therefore best used to treat soft tissues.[1] They also have good haemostatic property.

• Erbium wavelength is also absorbed by apatite crystals.[2] Therefore it can be used for the treatment of hard tissues like enamel,

dentin and bone. Newer lasers with radial firing tips have excellent cutting efficiency and can be used for root canal preparations as well.

LASER WELDING

Excellent weldability can be achieved for Co- Cr alloy and titanium alloy. Maximum depth of weld which can be achieved is 2mm. Welding can be done directly on master cast. It is possible to weld near acrylic resin or ceramic parts without causing any harm to the materials as they do not contain water in them. No welding intermediate is required when lasers are used for welding.[15] Microstructural changes due to rapid solidification stage, Microcracks and localized corrosion are disadvantages.

SAFTEY AND COST

An integral part of providing dental treatment with laser instrument is safety and Laser safety officer (LSO) is a designated, trained person who directs laser safety practices and ensures a safe environment for using it. Every clinician should be careful to prevent inadvertent irradiation and protective eyewear specific for the wavelength of laser in use must be worn by the patient, operator and assistant and in addition, should attend certificate courses by dental laser organizations and follow lasers safety guidelines; but the cost and size of laser device still constitute an obstacle for its routine application. While the laser is a powerful and useful instrument, there are some potential hazards in its use. So safety becomes an integral part of providing dental treatment with laser instrument. Various jurisdictions, standards-making bodies, legislation, and government regulations have defined laser safety protocols for the dentist, patient, and staff that must be followed in the clinical practice. Among them:

U.S.A. ORGANIZATIONS

The American National Standard Institute (ANSI) provides guidance for the safe use of laser systems by specifically defining control measures for lasers. The U.S. Food and Drug Administration (FDA) and its Center for Devices and Radiological Health (CDRH) together standardize the manufacturing of laser products and enforce compliance. The Occupational Safety and Health Administration (OSHA) of the U.S. Department of Labor stipulates the requirements for a safe workplace environment.

REGULATIONS IN EUROPE

The International Electro technical Commission (IEC) 60825-1 is the highest internationally accepted European standard for laser safety. Worldwide, appropriate safety measures such as a designated laser safety officer, device safety mechanisms, protective eyewear, masks, nonreflecting instruments, warning signs, and restricted access of any unauthorized person in the operating area are some of protocols that should be implemented before the commencement of any procedure with dental lasers.

OTHER USES

Lasers can be used for the curing of dental materials like composites18. For this purpose argon laser is the laser of choice. Prosthesis and ID discs can be marked with laser [Nd:YVO4 laser engraving unit], ID markings were done on the metal parts of prosthesis and prefabricated stainless steel crown.[18] Bleaching is another important treatment which can be accomplished by lasers. Gingival enlargements during and post orthodontic treatment can be treated effectively with lasers.

UPDATING YOUR SELF AND YOUR DENTAL TEAM

Knowledge is today's most important and effective competitive advantage. In an era characterized by rapid change and uncertainty, successful organizations depend on knowledge as their principal way to create

value and ongoing growth. Various Continuing Dental Education (CDE) programs, lectures, workshops, conferences, and courses are available to help the dentist and staff learns and master laser techniques. The Academy of Laser Dentistry (ALD) is one such organization devoted to clinical education, research, and the development of standards and guidelines for the safe and effective use of laser technology worldwide. Founded in 1993, ALD includes among its members top clinicians, academicians, and researchers in all laser wavelengths. The main objective of these courses and academies is to understand laser physics, and promote safe and effective use of lasers on patients.

FURTHER SCOPE OF RESEARCH

Hard tissue laser applications like crown preparations, bone recontouring and implant placement are undergoing rapid changes in technologic advances. An evolution is occurring as dentists move from simple mechanics to boundless area of photonics. Through the continued development of laser technology, laser dentistry may become a separate branch in dentistry.

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