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Lasers in Dentistry-Short Review

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Abstract

Aim: This study aims in systematic review on lasers that are used in various fields of Dentistry.
Objective: To determine the use of lasers in various fields of Dentistry.
Background: The development of the lasers has been of great interest among dental practitioners, scientists and patients to use this tool to ensure the treatment easier and effective. With the availability and future development of different laser wavelengths and methods of pulsing, much interest is developing in this growing field. This article thus reviews the role of lasers in dentistry.
Reason To Do The Article: Use of lasers is the upcoming technology in dentistry which has multiple benefits. Hence the topic is chosen.
Result: This study results in an overview of the lasers used in dentistry which plays a significant role in day to day life of dentists.
Conclusion: The lasers are an effective use in dentistry if used in appropriate manner by knowing the safety measures.

Keywords: Laser,stimulated emission,coherence,monochromaticity.

INTRODUCTION

The word Laser stands for "Light Amplification by Stimulated Emission of Radiation". The invention of the laser was not intended but was the result of many ideas and discoveries, each building upon the ones that came before it in the past century. One such idea is the optical MASER (Microwave Amplification by Stimulated Emission of Radiation) designed by Charles Townes in September 1957 which is the predecessor of laser technology. The term laser was first coined by Gordon Gould, a graduate of Columbia University in 1957. After various attempts made by many scientists, the first successful device (ruby laser) was built by Theodore H. Maiman of California in July 7, 1960. This invention excited scientists all over the world who started to find various methods to produce lasers and also the applications of it. Thus the new era of laser had begun. Lasers differ from other ordinary light sources by the following three unique properties[1-5]:

- Monochromaticity:
  Laser is composed of rays of same colour and wavelength unlike ordinary lights,which has a band of colours at different wavelength.
- Directionality:
  Every ray in laser beam will travel exactly in the same direction. Whereas ordinary light travels in different direction.
- Coherence:
  The rays in a laser are accurately synchronised with each other unlike ordinary lights.
  Thus, laser is considered as the purest form of the light.

The basic principles involved in laser action are,

- Quantum nature of light:
  The energy levels of atoms and molecules can have only certain quantised values. Transition between these quantised states occur by the photon process absorption,emission,stimulated emission.
- Stimulated emission:
  If an electron is already in an excited state, then an incoming photon for which the quantum energy is equal to the energy difference between its present level and a lower level can "stimulate" a transition to a lower level, producing a second photon of the same energy.

The basic components of laser are,

- ❖ Optical resonator:
  The part of the lasers which consists of two mirrors, one highly reflective and one partly reflective, placed on either side of the laser lamp.
- ❖ Laser gain / active laser medium:
  Laser active medium is the source of optical gain within a laser which results from stimulated emission. The medium is excited by a pump source. Example: semiconductors like gallium arsenide, gallium nitrate and gases like mixtures of helium and neon etc.
- ❖ Pump source:
  Pumping is the act of energy transfer from an external source into the gain medium of a laser. Such pumping methods are optical pumping, electrical pumping, gas dynamic pumping etc.

WORKING OF LASERS:

A laser is created when the electrons in atoms in special glasses, crystals, or gases absorb energy from an electrical current or another laser and become "excited." The excited electrons move from a lower-energy orbit to a higher-energy orbit around the atom's nucleus. When they return to their normal or "ground" state, the electrons emit photons (particles of light)[7]. An atom may undergo transition between two energy states E_1 and E_2 if it emits or absorbs a photon of appropriate energy. The life time of the atoms in the excited state is normally 10^{-8} seconds.

Some of the excited energy levels have greater life times for atoms. Such energy levels are called as the metastable states.

CONDITIONS TO ACHIEVE LASER ACTION

1. There must be an inverted population i.e. More atoms in the excited state than in the ground state.
2. The excited state must be an metastable state.
3. The emitted photons must stimulate further emission. This is achieved by the use of the reflecting mirrors at the two ends of the system.

LASERS IN DENTISTRY

The common dental lasers that are used today are erbium, Nd:YAG(Neodymium Yttrium Aluminium Garnet)
, diode, and CO2. Each type of laser has specific biological effects and procedures associated with them[10] . A solid understanding of each of these categories of devices is imperative for any clinician hoping to pursue laser use in their practice. The dental lasers produce both visible and invisible lights which has its pros and cons. There are four dental lasers that emit visible lights. They have their particular wavelength and colour that act on the particular tissue sites7 to achieve their goal (table:1). The dental laser emit invisible light in the near, far, and middle infrared portion of the electromagnetic spectrum. These includes photobiomodulation devices with which wavelengths between 800&900nm, as well as surgical instruments(table:2). Lasers play an important role in dentistry as it is beneficial in treating a wide range of dental complications and also in therapeutic treatments that aims in the management of tissues.There are three types of lasers that are used in dentistry they are,

- Soft tissue lasers.
- Hard tissue lasers.
- Non surgical lasers.

Lasers are also used for diagnosis purposes such as, detection of pulp vitality; doppler flowmetry; laser fluorescence (i.e.detection of caries, bacteria, nad changes in the diagnosis of cancer). Lasers also has an impact on restorations, bleaching agents and as a laser-induced analgesics.

LASERS ON TISSUES

When a laser beam is produced, its target is at the site of the tissues. As the beam energy meets with the biological interface it produces tissue interactions. The biological effects that occur when the laser beam enters the tissues are:

- Fluorescence.
- Photo thermal.
- Photo disrupting.
- Photo chemical.
- Photo bio modulation.

Among the 4 interactions absorption is the most important interaction.Each wavelength of the laser beam absorb their energy and the absorbed energy is then changed into thermal or/and mechanical energy which is used to perform its action.The lasers like Diodes and Nd:YAG are predominantly absorbed by haemoglobin and melanin(pigments) whereas, Erbium and CO2 lasers;are by water and hydroxyapatite.And the diode & Nd:YAG(short, near infrared) lasers are likely to penetrate the tissues deeply than the erbium & CO2 (long, mid infrared) lasers.

Types of lasers	Wavelength	Colour
Argon	488nm 514nm	Blue. Blue-green.
Nd:YAG	532nm	Green.
Low-level (Non surgical power)	635nm	Red.
Low-level caries detector.	655nm	Red.

Table 1:dental lasers that emit visible lights.

Lasers	Wavelength range
Diode	800nm 1064nm
Nd:YAG	1064nm
Er,Cr:YSGG	2780nm
Er:YAG	2940nm
CO2	9300nm 10,600nm

Table 2:dental lasers that emit invisible lights and their corresponding wavelengths. Nd:YAG*- Neodymium Yttrium Aluminium Garnet laser, Er,Cr:YSGG*- Erbium-Chromium-doped Yttrium-Scandium-GalliumGarnet laser,CO2*-Carbon dioxide laser.

SOFT TISSUE LASERS IN DENTISTRY

Lasers have been used for oral soft tissue dental procedures for more than 30 years, and have been researched since the middle 1960s[1].soft tissue lasers have been successfully used in periodontal surgical procedures. This includes,periodontal flap surgeries,osseous resection, gingivectomy, gingivoplasty ,frenectomies ,abalation of lesions, excisional and incisional biopsies,tuberosity reductions of soft tissue, periodontal pocket treatment, crown lengthening and operculum removal. The laser is also used for the perio- implantitis treatment such as keeping the peri-implant tissue healthy during Implant therapy[2-4]. Soft tissue lasers also have an impact on oral surgery. Lasers can be a useful treatment modality for obtaining biopsy specimens without tissue destruction. The some of the application in oral surgery are; homeostasis,cysts, benign tumour, malformation, scar correction, preprosthetic surgeries, low level laser therapy[1,5]. In orthodontics, the soft tissue laser improve gingival shape and contour, lengthen crowns, idealise tooth proportionality. The some of the uses in orthodontics are Aesthetic gingival recontouring, Soft tissue crown lengthening.Exposure of soft-tissue impacted teeth,Removal of inflamed and hypertrophic tissue,Frenectomy, Tissue removal at the site for mini screw, Low Level Laser Therapy[1,6]. The soft tissue lasers application on conservative dentistry and endodontics are root canal treatment,pulp capping & pulpotomy, dentinal hypersensitivity, sterilisation of root canals[1].

HARD TISSUE LASER APPLICATION

1) Caries removal.
2) Cavity preparation.
3) Re-contouring of bone(crown lengthening).
4) Endodontics(root canal treatment,Apicectomy and sterilisation).
5) Class 1,2,3,4 and 5 caries removal.
6) Enameloplasty, excavation of pits and fissures for Placement of sealants.
7) Hard tissue surface roughening or etching.

ADVANTAGES OF LASERS

1) Minimise bleeding and swelling .
2) Decrease the pain.
3) Reduce anxiety in patients.
4) Reduce bacterial infections(sterilises the area being worked).
5) During cavity treatment it preserves the tooth healthy.
6) Faster healing.
7) Better visualisation.

DISADVANTAGES OF LASERS

Though lasers play an important role in dentistry and has various advantages, it also suffers some disadvantages. The some of the disadvantages are listed below as follows;

- Lasers can't be used in place of teeth with fillings in it.
- Ocular damage.
- Tissue damage.
- Do not eliminate the need for anaesthesia.
- Respiratory or environmental hazards.
- Combustion hazards.
- Electrical problems.
- More expensive since the cost of the laser is high.

SAFETY MEASURES

- It is not prescribed in patients with pacemakers, or used with precaution.
- Laser should not be used in the uterus region in pregnant women.
- Shouldn’t be used in epileptic patients or with frequency less than 800Hz
- Shouldn’t be used in patients with antecedent of arrhythmia or chest pain
- Shouldn’t be used on glands, e.g. thyroid gland
- Laser therapy should be avoid on tumorous tissues or benign tumours with malignant tendency
- Prescription of laser therapy is forbidden in patients with lupus or patients treated with substances sensible to light.
- Safety goggle should be worn by the patient and the dentists.
- Never look directly into the laser beam.
- Never move the laser machine during the treatment .
- Never use the laser in the presence of flammable anaesthetics.

CONCLUSION

The use of laser in dentistry is proven to be the beneficial in treating a wide range of dental conditions as well as a therapeutic tool in tissue management. On the other hand, the laser energy also pose risks at the same time. Hence,some safety measure are suggested to safeguard those personnel whom ever is involved in dental treatment using lasers.

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