Dr. Nada Jafer Radhi (College of Dentistry/ University of Baghdad)

Uses of LASER in dentistry

Laser irradiation can be a useful tool for many procedures in medicine, dentistry, biology, physiotherapy, and other life sciences. The clinical use of laser irradiation is based on a wide range of physical phenomena of light interaction with biological tissues, cells, and fluids.

What is LASER?

The acronym 'LASER' stands for 'Light Amplification by Stimulated Emission of Radiation.' Lasers work as a result of resonant effects. They produce heat by converting electromagnetic energy into thermal energy. Their working principle is generation of monochromatic, coherent and collimated radiation by suitable laser medium in an optical resonator. Laser emission modes play an important role in increasing the tissues temperature. The thermal effect of laser energy on tissues primarily involves the water content of tissues and the temperature rise of tissues. The thermal effects are necessary for clinical procedures such as cutting, coagulation, vaporization, and ablation of biological tissues, and to achieve these, high power lasers are used. These lasers increase tissue temperature by 1 °C or more and, in this way, promote coagulation, cutting, vaporization or ablation of tissues.

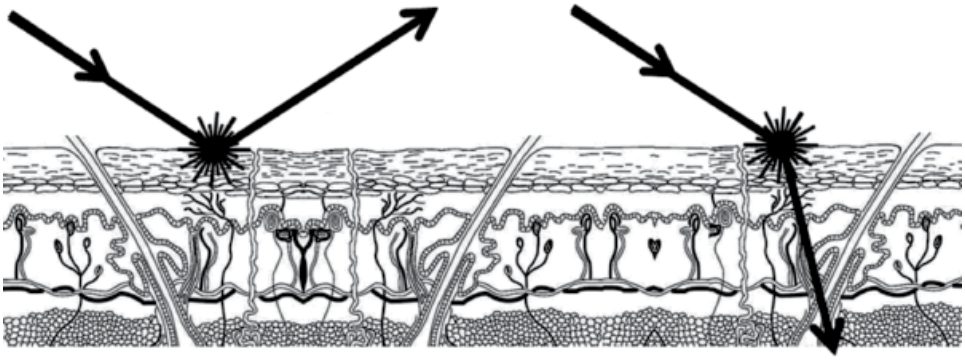
Laser available for utilization in dentistry with high power include CO_2 (carbon dioxide 9300nm or 10600nm), Er:YAG (Erbium 2940nm), Ho:YAG (Holmium Yttrium Aluminum Garnet 2100nm), Nd:YAG (Neodymium Yttrium Aluminum Garnet 1064nm) and argon lasers (488nm or 514nm) as well as other types of laser. Laser is being used in almost all the specialties of dentistry. More recently,

researchers have reported the use of other type of laser systems in dentistry, in which non-linear interactions with biological tissues take place. These systems have extremely short pulse lengths (femtoseconds, fs) and are called *ultrashort pulsed lasers* (USPLs).

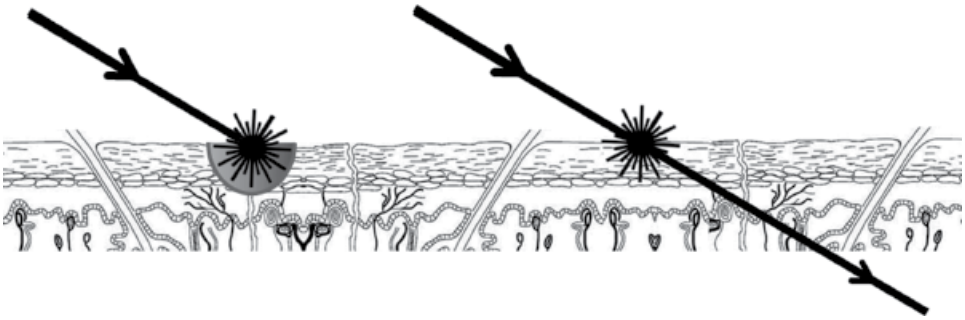
Laser effects on tissues: Depending on the optical properties of the tissues, the light energy from a laser may have four different interactions with the target tissues, as follows:

- Reflection.
- Transmission.
- Scattering.
- Absorption.

Each of the processes of laser interaction with biological tissues depends on the characteristics of the laser system, such as wavelength, pulse duration, pulse energy, repetition rate, beam spot size, delivery method, laser beam characteristics and optical properties of tissue.



Reflection **Refraction**



Absorption **Transmission**

Role of laser in preventive dentistry

Laser dentistry when combined with conventional preventive dentistry techniques has enhanced the effect of preventive measure. Action of preventive techniques likes fluoride applications, pit and fissure sealants etc. have more successful results after combining them with lasers.

Certain roles of laser in prevention of dental caries as follows:

Since the development of the first laser by Maiman in 1960, enhancement of enamel resistance to caries using lasers has been reported by many studies. CO_2 lasers were the first to be investigated in the reduction of acid dissolution of enamel. Other lasers have been investigated as Nd:YAG, Er:YAG, argon laser and others.

To prevent dental caries, the energy generated by the lasers must be highly absorbed by the dental substrates and efficiently converted into thermal energy, which is confined to the surface and can modify the structure and chemical composition of these substrates to promote increased acid resistance. A greater selectivity of wavelengths in the targeting and removal of the carbonate group from enamel mineral molecule results in a greatly increased acid-resistant compound. Additionally, the altered mineral has greater uptake of topically applied fluoride.

Several hypotheses have been proposed to explain the reduction of enamel demineralization after irradiation with lasers:

- The prevention of caries by laser irradiation could result from a combination of reduced permeability and solubility as a result of the melting, recrystallization, and fusion of hydroxyapatite crystals that seal the enamel surface by decreasing the interprismatic spaces.

- The change in the solubility of heated apatite as less soluble compounds are formed. However, the analysis of irradiated surfaces with melting zones revealed the presence of calcium oxide phosphate, which is less soluble than the group of phosphate minerals commonly present in enamel. Reduction of carbonate content is usual in irradiated enamel and can also inhibit enamel demineralization.

- CO_2 laser can be used safely to alter the enamel surface and make it more resistant to caries, without causing dental pulp damage. Also enhancing fluoride uptake into the crystalline structure of the tooth in the form of firmly bound fluoride.

- Argon laser: The proposed mechanism for the protective effect of argon laser irradiation against both caries initiation and progression is alteration of the characteristics of the enamel surface by creating microspaces that trap calcium, phosphate, and fluoride ions during an acid challenge. The ions are incorporated into the enamel surface. Thus, the enamel irradiated with the argon laser has an increased affinity for calcium, phosphate, and fluoride ions. The use of argon lasers with and without fluoride may be a simple technique to reduce the caries susceptibility of enamel.

- Nd:YAG laser: Similar mechanisms to those for CO_2 lasers have been suggested for Nd:YAG lasers in caries prevention. However, unlike the CO_2 laser, which is the most efficiently absorbed laser by dental enamel, the Nd:YAG laser is not effectively absorbed by human enamel. Thus, its efficient use in this substrate depends on the application of a photosensitizer.

- Ruby laser is less effective in decreasing subsurface demineralization during caries process. The extensive heating generated by this type of laser resulted in structural damage of tooth.

- Erbium lasers: Er:YAG used in caries prevention as greatly increased acid-resistant of enamel.

Benefits of dental lasers

- The main benefit is the ability to interact selectively and precisely with diseased tissues.
- Reduce the amount of bacteria and other pathogens.
- The cavity preparation by laser has been disinfectant because of the bactericidal nature of laser energy.

Drawbacks of dental lasers

- The disadvantages of dental laser are the relatively high cost and the required training.
- Another drawback of erbium laser is the inability to remove metallic restorations.
- No single wavelength will optimally treat all dental tissues.

Laser Safety:

- All laser devices have complete instructions on the safe use of the machine.
- Appropriate protective eyewear must be worn by the patient and dental team.
- Masks must be of appropriate filtering capacity.

Laser Safety Officer (LSO) duties are as follows:

- Understandable the operational characteristics of laser.
- Knows output limitations of the device.
- Supervises staff education and training.
- Oversees personal protective wear.
- Knows the potential hazard of the laser.