Conservative Dentistry

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Dental Laser

Laser: is an acronyum standing for **l**ight **a**mplification by **s**timulated **e**mission of **r**adiation.

Laser apparatus:

All lasers apparatus have similar fundamental elements which are:

A. Lasing media (active media).

B. An optical resonators.

C. An energy source.

A-Lasing media (active media):

The active media may be in the form of a gas, sold, atoms or ions host lasers are named with regard to the substance of active media that is used to create the actual laser light. (Ex. $C0_2$ laser has lasing media containing $C0_2$ gas).

B. Optical resonators:

The optical resonator is essentially an arrangement of two mirrors. Basically it is consist of fully reflective mirror at one end of lasing media and partially reflective mirror at the other end of lasing media.

C. Energy source.

The atoms or molecules of the lasing media need to be excited so that photons of laser light are emitted. The energy for this excitation may be provided by electric discharge, high power xenon flash lamps or even other laser.

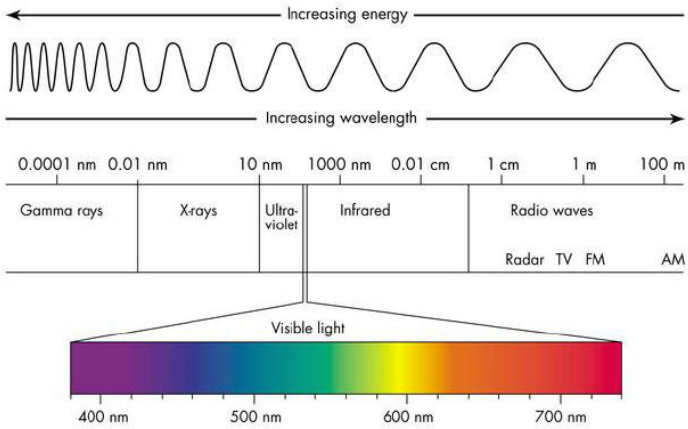
Properties of laser light:

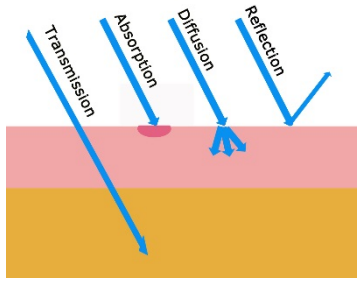
There are several important properties of laser light that distinguish it from white (ordinary) light. These singular properties of laser light that make it useful in medicine and dental uses are:

1-Monochromaticity:

The laser light produced by particular laser device will be of characteristic wavelength, if the light produced, is in the visible spectrum (0.385-0.760 μm) it will be seen as a beam of intense color. However, dental lasers can produce light from the ultraviolet (0.193 μm) to the infrared (10.6μm) depending on lasing media.

2 **.Direction ally**: The laser light is perfectly parallel when leaving the laser aperture, however there is little divergence of laser beam as it exits the laser device, this explains ability of laser beam to trained to long distance with laser light maintains brightness. In practice the beam is often optically focused to a point at convenient working distance from the tissue being irradiated by means of lens.





Laser Effects on Tissue

Depending on the optical properties of the tissue, the light energy from a laser may have four different interactions with the target tissue as follows: 1- Reflection

2- Transmission

3- Scattering

4- Absorption

Mechanisms of laser- tissue interactions:

The light when attacks the tissues interact with tissue, the light energy when attacks the tissues absorbed by tissue transmitted and scattered thought tissue and some energy reflected away from the tissue, the results of this interactions is different modes of interaction (different affects).There are many modes of interaction between lasers and tissues.

1. Coagulation: is the mode appropriate for working with soft tissues. If the laser beam incident to tissue with a normal body temperature of 37^0C heats the tissues over 60^0C. The tissues undergo coagulation phenomenon.

2. Photo-vaporization: Photo-vaporization takes place when layers of tissue are heated to high temperatures and liberated as for example when using carbon dioxide laser with intense, highly focused laser radiation produces surface temperatures exceeding 100^0C which cause tissue vaporization.

3. **Photo-ablation**: This mode of action occurs when the energy of the laser is used under well controlled to selectively remove thin layers of material causing relatively little thermal damage in the adjacent areas.

4. Photo-disruption: The photo-disruption occurs when the extremely localized high power pulse tends to generate very high instaneous electric field values, which causes electrical breakdown at the tissue interface resulting in ionization, plasma production.

Application of Laser in Conservative Dentistry.

1 - Cavity Preparation

Recently, the use of laser technology has been introduced as an

alternative to traditional mechanical rotating instruments for cavity preparation. Bonding of composite resin to Er :YAG and Er.Cr. : YSGG irradiated enamel and dentin surfaces, more than bonding composite resin to diamond-bur prepared surfaces. Dental lasers in cavity preparation free from noise, vibration and no need for local anesthesia would therefore, seem to have an assured future.

Er,Cr:YSGG laser system used in conjugation with air-water spray is effective for preparation of Class I, III and V cavities more conservative cavity preparation because the laser can remove the caries without removal sound enamel below the lesion. The composite resin restorations have more retention and less microleakage.

2- Caries detection

The argon laser energy will offer diagnostic capabilities when used to illuminate teeth. When illuminated with argon laser light, carious tissue has a clinical appearance of a dark, fiery, orange color and is easily differentiated from sound tooth structure. Decalcified areas appear as a dull, opaque, orange color.

A diode laser (DIAGNO dent, 655 nm, modulated, 1 mW peak power) depend on laser/light fluorescence appears to show the greatest promise for the detection of dental caries. White spot lesions without the involvement of bacteria, do not produce a significant increase in fluorescence compared with sound surfaces, distinct increase in fluorescence when the caries process in more advanced stages. Bacteria or their metabolites could contribute the fluorescence of carious lesions.

3- Polymerization (curing) of composite resin.

The argon laser with 488 nm wavelength is used to catalyze dental resin polymerization. This use of the argon laser allows for faster curing

of dental resins, and causes the dental resin to have a strong bond to the tooth and less polymerization shrinkage as compared with composite resin cured by the conventional visible light. The optimal curing time for conventional visible light is 44 seconds while for argon laser is 8 seconds.

4- Dental bleaching

Dental bleaching is whiting of discolored teeth can be done for vital teeth or for root canal treated teeth.

The 35 % of hydrogen peroxide is chemical agent widely used for dental bleaching (tooth whitening) and recently the Argon, diode and $C0_2$ lasers was used for dental bleaching either alone or in combination with chemical bleaching agent.

The Argon laser is safer and more efficient than diode laser for tooth whitening procedure, and the best results in dental bleaching were achieved with the combination of Argon laser irradiation and the bleaching agents (35% hydrogen peroxide). The Argon laser is used to enhance the activation of bleaching agent.

Some dentist use both Argon and $C0_2$ lasers in combination with peroxide solution to promote penetration of bleaching agent into the tooth to provide bleaching below tooth surface giving better and faster bleaching

5- Enamel etching and Dentin conditioning.

The Er :YAG and Er.Cr. : YSGG and $C0_2$ lasers energy is absorbed strongly by enamel and dentine and can produce both chemical and physical changes on the enamel surface which can be of therapeutic value. Roughening of the enamel surface through the creation of bubble-like inclusions because laser treatment induces melting and recrystalization of hydroxylapatite resulting the formation of bubbles-like inclusions.

Etching enamel and dentine using pulsed carbon dioxide (C02) laser radiation has been shown to give acceptable bond strengths when hydrophobic enamel bonding resins are used between the lased surface and composite resin.

The effects of laser on dentine have many beneficial like desensitization of hypersensitive exposed dentine by melting and recrystalization of dentine causing closure of open dental tubules.

Laser safety:

Precaution for dental staff and patients are essential during laser procedures to protect non-target tissue particularly the eyes from stray beams. Reflective surfaces such as instruments, mirrors and even polished restorations have potential to redirect laser energy. Matte instruments are advisable, also protective eyeglasses for patient and staff. Usually green safety glasses are required for use with Nd : YAG lasers and amber colored glasses for use with Argon laser, while for CO_2 laser clear glasses are indicated. In addition, the patient eyes should be covered with moist gauze pads.

The non-target oral tissues should be shielded with wet gauze packs. The laser plume created when tissue vaporizes should be considered infectious thus an appropriate evacuation system to draw off and filter the plume is essential. As with any procedure involving potential contamination by blood or other body fluids, the operator and assistant should wear glasses and surgical masks. Extreme caution must be used when, operating a laser in the area with explosive gasses such as anesthetics.

°C	Degree Celsius
Co_2	Carbon dioxide
µm	Micrometre
Er:Cr:YSGG	erbium, chromium: yttrium scandium–gallium–garnet
Er:YAG	Erbium yttrium aluminium garnet

Nd:YAG	Neodymium yttrium aluminium garnet
nm	Nanometre