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Lec. 8 **Restorative dentistry**

Dental Laser

The word **(Laser)** is an acronym of **L**ight **A**mplification by **S**timulated **E**mission of **R**adiation.

Basic Component of Lasers apparatus:

Several components are necessary to constitute a dental laser unit, which are:

1. **Lasing media (active media):** The active media may be solid, liquid or gaseous; most lasers are named with regard to the substance of active media that is used to create the actual laser light. (e.g. CO2 laser has lasing, media containing CO2 gas).
2. **An optical resonator**: The optical resonator is essentially an arrangement of two mirrors at the ends of lasing media. One of these mirrors must be a complete reflector, and the other a semi-reflector.
3. **An energy source**: The atoms or molecules of the lasing media need to be excited so that photons of laser light are emitted the energy source necessary for this stimulation. This source of energy is usually represented by an electric coil or a diode laser or a flash lamp.
4. **A controller Subsystem and Cooler**: that is a software, which controls the modality and parameter of laser emission, and **a *cooler*** that necessary for cooling the laser system.
5. **The delivery system**: that transports the laser energy to a terminal *handpiece* and *tips* and finally to the tissue**.**

Properties of laser light:

Several important properties of laser light, which distinguish it from the ordinary light and make it useful for medical and dental uses.

Monochromaticity: is a unique property of laser light. Ordinary colored light, such as that emitted by colored lamps, consists of a broad range of wavelengths covering a particular portion of the visible light spectrum. The beam of a laser, on the other hand, is a very pure color. It consists of an extremely narrow range of wavelengths. It is said to be nearly “monochromatic.”

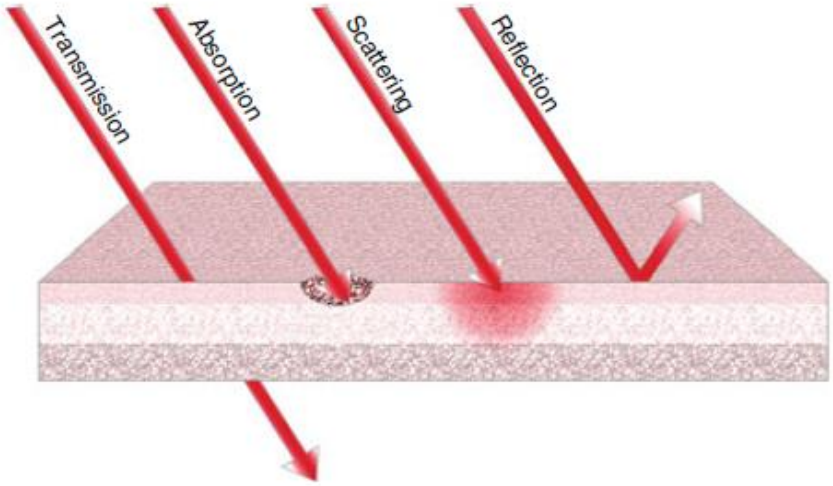
Directionality (Collimation): is the characteristic of laser light that makes it travel in a single direction, with only a narrow cone of divergence. This explains ability of laser beam to train to long distance with maintains brightness.

Coherence: laser light unlike ordinary light source, their waves all in phase and the waves reinforce each other while in an ordinary light, the waves cancel each other to a greater or a lesser extent.

Brightness: Another property of laser light that distinguishes it from ordinary light sources is brightness. This property arises because of the parallelism or collimation of the laser light when it moves through space maintaining its concentration.

Laser- tissue interactions:

The interaction of laser light with biological tissues depends on the wavelength and the optical properties of the target tissue. Resulting in four types of interactions: Reflection, Scattering, Absorption, and Transmission.



There are many modes of interaction between lasers and tissues:

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

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

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.

Types of lasers in dentistry:

Carbon dioxide laser ($C0_2$ laser): The carbon dioxide lasers have a gas lasing media and fall in infrared range of the spectrum. This laser has affinity to wet tissues regardless of tissue color. This laser is indicated for the treatment of mucosal lesion, since it has a limited penetration depth.

Neodymium: yttrium aluminum garnet (Nd:YAG) laser: This laser has a solid active lasing media of a crystal of yttrium-aluminum garnet dropped with neodymium, This laser is not well absorbed by water but is absorbed well by pigmented tissue like hemoglobin and melanin.

Diode laser: These lasers are excellent soft tissue surgical lasers, so surgery can be performed safely as are poorly absorbed by the dental hard tissue. This laser is indicated for gingivoplasty, sulcular debridement and deeper coagulation process on gingival and mucosa.

Argon lasers: Argon laser light has two primary wavelengths; 488 nm and 514 nm, these wavelengths manifest as blue and green visible light respectively, the lasing media is the argon gas. It is not absorbed well by hard tissues and no particular care is needed to protect the teeth during laser surgery. The argon lasers with wavelength of 488 nm has ability to cure composite resins. While argon laser with wavelength of 514 nm can be used mainly for soft tissue procedures and coagulation. Both wavelength is used as an aid for caries detection.

Erbium: yttrium aluminum garnet (Er: YAG) laser: This type of laser is has ability to ablate or cut dental hard tissue effectively and efficiently. The Er: YAG is well absorbed by water and hydroxylapatite, which responsible for its efficiency in cutting enamel and dentine.

Application of dental laser in Restorative dentistry

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- red color and is easily differentiated from sound tooth structure. Decalcified areas appear as a dull, opaque, orange color.

A diode laser depend on laser/light fluorescence 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 to the fluorescence of carious lesions.

Cavity Preparation:

Recently, the use of laser technology has been introduced as an alternative to traditional mechanical rotating instruments for cavity preparation. Dental lasers in cavity preparation free from noise, vibration and no need for local anesthesia would therefore, seem to have an assured future.

Polymerization (curing) of composite resin:

The argon laser with 488nm wavelength is used for 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.

Enamel etching and Dentin conditioning:

Etching enamel and dentine using pulsed carbon dioxide ($C0_2$) laser radiation has been shown to give acceptable bond strengths. The effects of laser on dentine have many beneficial like desensitization of hypersensitive exposed dentine by melting and recrystallization of dentine causing closure of open dental tubules.

Dental bleaching:

Dental bleaching is whiting of discolored teeth can done for vital teeth or for root canal treated teeth. The 35 % of hydrogen peroxide is chemical agent widely used for dental bleaching. The Argon, diode and $C0_2$ lasers was used for dental bleaching 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.

Laser Advantages in Restorative Dentistry:

1. It has high affinity for carious tissues and so is selective and minimally invasive.
2. It can be used on both hard and soft tissues, including the pulp.
3. It is safe due to the absence of the use of rotating instruments in the mouth.
4. It provides comfort because it works without contact and vibration on the surface.
5. It is less painful, and in many cases, the use of local anaesthetics can be avoided.
6. It has a favorable psychological impact on phobic and paediatric patients.

Laser hazard:

The lasers have many adverse effects when used with inappropriate handling, these effects may effect on patient or dental staff.

Retinae adverse effects:

The effect of laser radiation upon retinal tissue may be a temporary change without pathological reactions, or it may be more sever, varying from small indistinguishable lesions to gross damage of the retina. With increasing energy, lesion may occur, progressing from edema to charring with hemorrhaging and secondary effects about the lesion. With very high energy, gases form, which can disrupt the retina and may create small explosions in the eye.

Corneal and skin effects:

Ultraviolet radiation (200-400nm) is absorbed at the cornea and can cause painful damage. It can cause conjunctivitis and erythema to the face and other exposed tissue. The severity depending on the wavelength of the ultraviolet radiation.

Airborne contaminations:

The laser smocks or vapor emitted from the site of application during exposures to laser energy is regarded as potentially hazard. The $C0_2$ smocks have harmful effect on the respiratory system, thus evacuation and ventilation to the outside and adequate suction in the lasing site must be maintained at all time.

Laser safety:

Precaution for dental staff and patients are essential, 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. 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.