Operative Dentistry

Lecture (13)

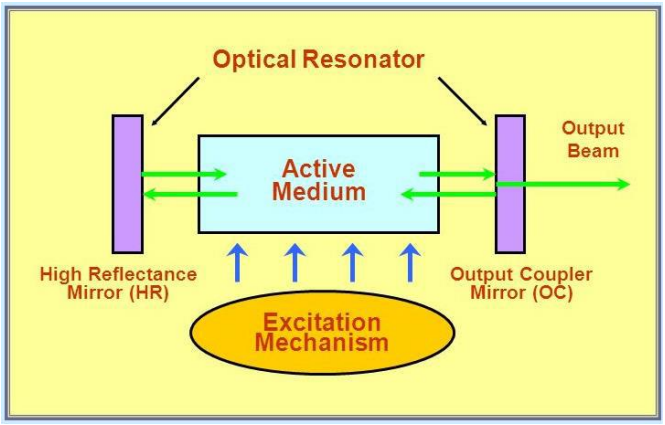
Dental Laser

Laser: Is an acronym standing for light amplification by stimulated emission of radiation. A laser is a device that emits light through a process of optical amplification based on the stimulated emission of electromagnetic radiation.

Laser apparatus: All lasers apparatus have similar fundamental elements which are:

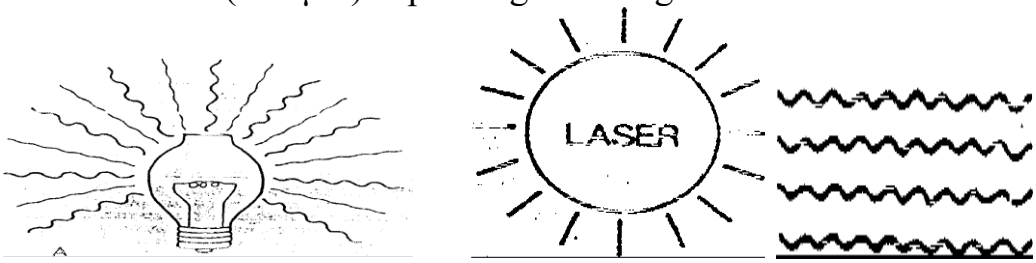
A. Lasing media (active media).
B. An optical resonators.
C. An energy source.

- A. Lasing media (active media): The active media may be in the form of a gas, sold, atoms or ions. Most Lasers are named with regard to the substance of active media that is used to create the actual laser light. (Ex. CO2 laser has lasing media containing CO2 gas).
- B. Optical resonators: The optical resonator is essentially an arrangement of two mirrors. Basically, it is consisting 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 another laser.



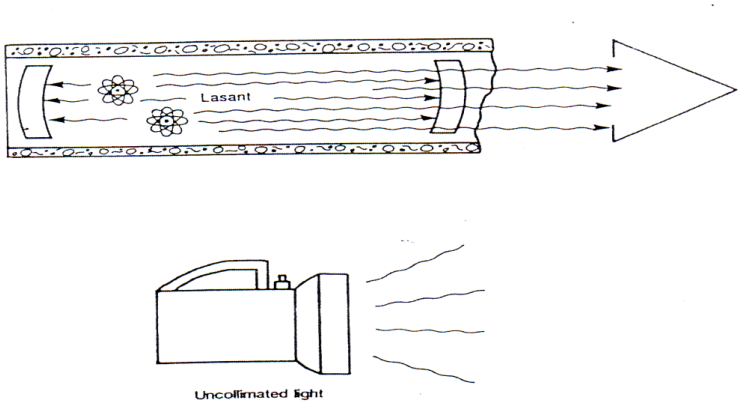
Properties of laser light: There are several important properties of laser light that distinguish it from white (ordinary) light. These singular properties of laser light that make it useful in medicine and dental uses are:

- ✓ 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.

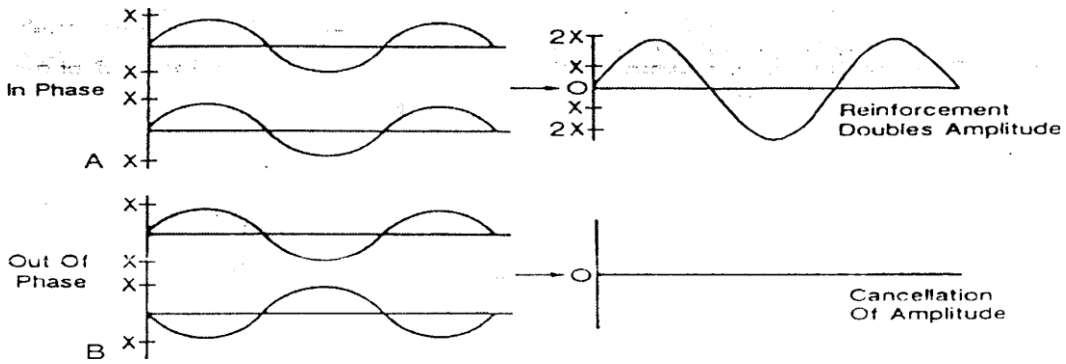


A. ordinary light B. Laser light

- ✓ 2.Directionally: The laser light is perfectly parallel when leaving the laser aperture (figure B), 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.



- ✓ 3.Coherence: Is a property of laser light that occurs when there is same fixed - phase relationship between two waves of laser light, thus each wave is in phase with the other waves both longitudinally and transversely. However, 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.



- ✓ 4. Brightness: Another property of laser light that distinguishes it from ordinary light sources is brightness. This property arises as a result of the parallelism or collimation of the laser light when it moves through space maintaining its concentration and thus, the characteristic high brightness occurs.

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:

- l. Coagulation: is the mode appropriate for working with soft tissues. If the laser beam incident to tissue with a normal body temperature of 37°C heats the tissues over 60°C. The tissues undergo coagulation phenomenon.
- 2. Photovaporization: Photovaporization 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 °C which cause tissue vaporization.
- 3. Photoablation: 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.

Types of lasers in dentistry:

1. Carbon dioxide laser (C021aser): The carbon dioxide lasers have a gas lasing media and fall into far infrared range of the spectrum. This laser has affinity to wet tissues regardless of tissue color. These lasers have wavelengths of 9.3μm and 10.6 μm.

2. Neodymium: yttrium aluminum garnet (Nd:YAG) laser: This laser has lasing media of a crystal of yttrium-aluminum garnet dropped with neodymium, the laser is in the near infrared range of electromagnetic spectrum with wavelength of 1.06 μm. This laser is not well absorbed by water but is absorbed well by pigmented tissue like hemoglobin and melanin. The Nd: YAG laser delivered by optical fibers.

3.Diode laser: The diode laser with wavelengths of 790 nm to 830 nm. It is within the infrared range and can be delivered with thin, flexible light conductor fibers. The diode laser is effective bactericidal in the sterilization of canals of teeth under endodontic treatment.

4.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. The argon laser light is absorbed well by oral soft tissue and provides excellent homeostasis, it has affinity for darker colored tissue and also has high affinity for hemoglobin making excellent coagulations. It is not absorbed well by hard tissues and no particular care is needed to protect the teeth during laser surgery. The argon lasers delivered by optical fibers. The argon lasers with wavelength of 488 nm has ability to cure composite resins. However, the argon laser when used to cure photo activated dental resin materials can reduce curing time, polymerization shrinkage and increase the physical properties and curing depth. While argon laser with wavelength of 514 nm can be used mainly for soft tissue procedures and coagulation.

5.Erbium: yttrium aluminum garnet (Er: YAG) laser: The wavelength of this type of laser is 2.94 μm, it 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 it's efficiency in cutting enamel and dentine, with this type of laser the pulpal temperature remained well below the critical temperature (below 5.5oC more than body temperature) so the pulpal response to cavity preparation with Er: YAG laser was minimal, comparable or less than the pulpal response created by a high speed turbine hand piece, the cavity prepare by Er: YAG laser has walls are not as smooth as that achieved with high speed hand piece but appear similar to acid-etched surface and if it is used with

acid etch procedure produce more bond strength between composite restoration and tooth surface. This laser usually delivered by optical fibers with water spray that serves as cooling system during tooth cutting, also the water increases the efficiency of the cutting.

6.Excimer lasers: These lasers combine halogen and a noble gas such as argon fluoride, with 193 nm wavelength or xenon chloride with 308 nm wavelength and krypton -fluoride with 248nm as the active medium. Eximer lasers operating in the ultraviolet region. The argon fluoride laser is well suited or show selective removal of necrotic debris from the root canal during endodontic treatment and produce clean very smooth, crack and fissure free dentine walls.

7.Holmium: yttrium aluminum garnet (Ho:YAG) lasers: These lasers used for soft tissues have wavelength of 2120 nm and for hard tissue with wavelength of 2090 nm can be delivered through a fiber optic carrier. These lasers are invisible, it has ability to pass through water, these lasers have affinity to white tissue and cause coagulation can be used for ablation of bone, dentine, cementum, and carious enamel.

8.Erbium chromium: Yttrium scandium gallium garnet (Er.Cr.: YSGG) laser: This laser has a crystal media with wavelength of 2.78 μm. The laser delivered through a flexible fiber optic cable and focused through a contra-angled hand piece bearing a sapphire tip This laser absorbed by water molecules and also by hydroxyl group in enamel or dentine, thus the Erbium chromium: yttrium scandium gallium garnet. This laser is effective for caries removal and cavity preparation with less discomfort to the patient and better surface treatment enhance bonding of composite resin to the cavity walls.

Application of dental laser in conservative dentistry:

1. cavity preparation.
2. caries detection.
3. composite curing.
4. dental bleaching.
5. enamel bleaching and dentine conditioning.
6. endodontic instrumentation and sterilization of root canal or canals.