Operative Dentistry

Lecture (14)

Dental laser

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-red color and is easily differentiated from sound tooth structure. Decalcified areas appear as a dull, opaque, orange color. A diode laser (DIAGNOdent, 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 to the fluorescence of carious lesions.

3. Polymerization (curing) of composite resin: The argon laser with 488nm 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 CO2 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 CO2 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 CO2 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 (CO2) 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.

6. Uses of Laser in endodontic treatment:

A. Root canal preparation by laser: The hand instrumentation left some of the walls untouched and left smear layer containing bacteria covering the instrumented walls. The laser preparation on the other hand gives clean and smear layer free root canal walls with dentine has crusty, wavy aspect with open dentinal tubules. Usually combination of hand instrumentation and laser preparation gives better results, in this technique the apical region of the canal is hand instrumented to the size 15 K file then the laser energy will applied to the canal by optic fiber(200μm in diameter which equal to size 20 K-file) inserted to the working length and enlargement was performed circumferentially starting in apical third, then the middle third and finally the cervical third.

B. Sealing of the apex and dentinal tubules and repair crack in the tooth by laser: The laser with optic fiber made from hydroxyapatite can seal the root apex and plug open dentinal tubules and repair a crack in the tooth by melting and deposition of the hydroxyapatite fiber optic during laser application inside the root canal.

C. PIPS (Photon induced photoacoustic streaming): Irrigation of root canal system before three dimensional obturaion is very important step in elimination of smear layer and remnant debris in an inaccessible areas of root canal system. PIPS is a technique recently develop to assist in this process. Recent studies have reported how the use of an Er:YAG laser, equipped with the newly designed radial and stripped tip, in combination with 17% EDTA solution, using a very low pulse duration (50 microseconds) and low energy (20 mJ) resulted in effective debris and smear layer removal with minimal or no thermal damage to the organic dentinal structure through a photoacoustic technique called Photon Induced Photoacoustic Streaming or "PIPS™". Also, the same PIPS™ protocol in combination with 6% sodium hypochlorite solution has been investigated and shown to reduce the bacterial load and its associated biofilm in the root canal system three dimensionally.

D. Obturation of root canal by laser: The laser (Argon or CO2 or Nd:YAG laser) used to obturat the root canal through softening the gutta percha filling material by heat generated from laser application.

Power density and energy density:

- **The power density:** is simply the number of photons per unit area, power density is the most important factor in detection the effectiveness of any laser device. When using continuous laser systems power/ area functions are extremely important. To enhance the effectiveness of laser beam and to provide an increase in power, a focusing lens can reduce the diameter of the sport to produce greater power densities at focal spot area thus enhancing tissue effects of the laser, the power density will determine the ability of the laser to vaporize, excise and coagulate biologic tissue. To calculate power density expressed in watt per square centimeter it can be shown that the power density is directly proportional to the wattage employed and inversely proportional to the area of the spot therefore: Power density (watt/cm2) = power(watt) / area (cm2)

- **Energy density (energy flounce):** It is the energy perceived per unit area. It can be calculated from the product of power density and exposure time. Energy density is measured by (Joule/cm2). It determines the extent of tissue vaporization or coagulation or ablation. When using pulsed laser systems power/ time functions are extremely important. The energy density

is directly proportional to the power and exposure time and inversely proportional to the exposed surface area of the target tissue.
Energy density (Joule/cm2) = (power (watt) x exposure time (second))/area (cm2)

Laser hazard (adverse effects):

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

- ✓ A-Retinal 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. The mildest observable effect may be simple reddening. With increasing energy, lesion may occur, progressing from edema to charring with hemorrhaging and secondary effects about the lesion. With very high energy, gases from which can disrupt the retina and may create small explosions in the eye.
- ✓ B-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. The general effect of ultraviolet radiation is that of sever sun burn. Infrared radiation is also absorbed by the cornea and by the skin and is converted to heat, with the overall effect being a heating of the tissue on a localized basis. Many tissues are quite sensitive to thermal changes and can be damaged when even slight temperature change occur. Infrared radiation has been shown to cause eye lens opacities.
- ✓ C-Air borne contaminations: The laser smocks (plume) or vapor emitted from the site of application during exposures to laser energy, is regarded as potentially hazardous both in term of particulate and infectivity. The CO2 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 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 CO2 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.