

THE BASICS OF LASERS & ITS IMPLEMENTATION IN PROSTHETIC DENTISTRY

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INTRODUCTION

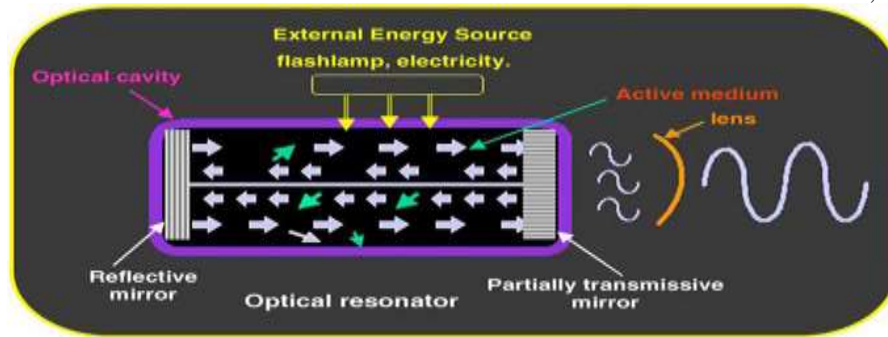
Laser is an acronym which stands for “Light Amplification by Stimulated Emission of Radiation”, which have been used in many fields. The use of Lasers in dentistry provides a new standard of care. The application and role of Lasers in prosthodontics in providing fixed dental prosthesis improves the standard of care for both the patients as well as the dentist due to its precise excision, a period of wound healing and their benefits of coagulation, which increases tissue response to provided surgeries. With a thorough knowledge of Lasers, their wavelength and target tissue interaction and better handling accurate care to the patients can be delivered.

HISTORY

- Breakthrough in Laser dentistry came in the mid1990s
- In 1956, Thomas Mailman exposed extracted tooth to prototype Ruby (694 nm) Laser, where transmission of Laser energy was found.
- In 1960, Goldman and Polanyi and Jako developed Ar, Nd:YAG, CO2 lasers from general areas of surgery to oral cavity.
- In late 1980s “selective thermolysis” where the pulsed dye lasers have been introduced
- Lasers in dentistry have been on 1989, where the American Dental Lasers have been used commercially with Nd:YAG
- In mid1990s, wavelengths were categorized diode laser 810-890 nm; Nd:YAG 1064 nm; Er: YSGG-2780 nm; Er:YAG-2940 nm; CO2-10600 nm.
- In 1989, Kuler and Hibst demonstrated the effectiveness of pulsed Er:YAG lasers (2780 nm)
- In 1997, laser armamentarium has been designed.

COMPONENTS OF A TYPICAL LASER

- 1) **Active medium:** The active medium is positioned within the laser cavity, an internally-polished tube, with mirrors co-axially positioned at each end and surrounded by the external energizing input, or pumping mechanism.
- 2) **Pumping mechanism:** This represents a man-made source of primary energy that excites the active medium. This is usually a light source, either a flashlight or arc-light, but can be a diode laser unit or an electromagnetic coil.
- 3) **Optical resonator:** Laser light produced by the stimulated active medium is bounced back and forth through the axis of the laser cavity, using two mirrors placed at either end, thus amplifying the power.
- 4) **Delivery system:** Depending upon the emitted wavelength, the delivery system may be a quartz fiber-optic, a flexible hollow waveguide, an articulated arm (incorporating mirrors), or a hand-piece containing the laser unit (at present only for low powered lasers).
- 5) **Cooling system:** Co-axial coolant systems may be air or water-assisted.
- 6) **Control panel:** This allows variation in power output with time.



LASER - TISSUE INTERACTION

Depending on the optical properties of the tissue, laser light can have four different interactions with the target tissue, i.e. absorption, transmission, reflection and scattering.

1) Absorption

The amount of energy absorbed by the tissue depends on following factors:

(a) Tissue Characteristics

- Pigmentation - The pigment melanin which imparts color to skin is strongly absorbed by short wavelengths. Hemoglobin reflects red wavelengths imparting color to arterial blood. It is therefore strongly absorbed by blue and green wavelengths whereas venous blood containing less oxygen absorbs more red light and appears darker.
- Water content - Water has varying degrees of absorption of different wavelengths.

(b) Laser Wavelength

- The shorter wavelengths (500–1,000 nm) are readily absorbed in pigmented tissue and blood elements.
- The longer wavelengths (2,000–10,600 nm) are more interactive with water and hydroxyapatite.

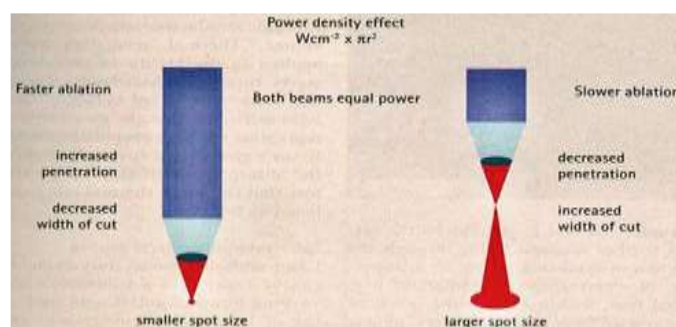
(c) Emission Mode

The dental laser device can emit light energy in three different modalities, namely:

- Continuous wave mode - the beam is emitted at only one power level for as long as the operator depresses the foot switch.
- Gated pulse mode - there are periodic alternations of the laser energy. This mode is achieved by the opening and closing of a mechanical shutter in front of the beam path of a continuous wave emission.
- Free-running pulsed mode (true-pulsed)- This emission is unique in that large peak energies of laser light are emitted for a short time span (microseconds) followed by a relatively long time in which the laser is off.

(d) Contact vs non-contact modes

- Laser light will undergo some divergence on exit from a quartz fiber delivery system and most non-fiber systems (hollow waveguide and articulated arm) use a focusing lens. Consequently, the 'spot size' of the beam, relative to the target tissue, will determine the concentration of laser energy - fluence and power density - being delivered over an area.
- It follows therefore, that during any laser tissue interaction the concentration of energy being delivered to a target site can be modified and controlled by moving the handpiece back and forth.



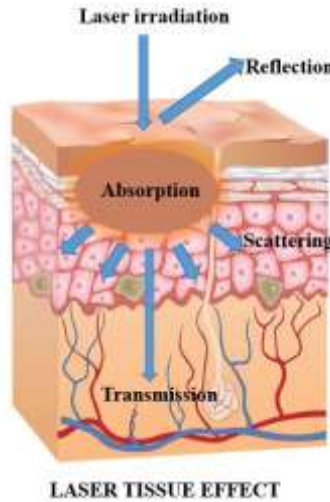
2) **Transmission:**

Is the inverse of absorption i.e. the laser energy passes directly through the tissue with no effect on the target tissue. This effect is highly dependent on the wavelength of laser light.

3) **Reflection:**The third effect is reflection, in which the laser beam bounces off the target surface with no effect. A caries detector is used to measure the degree of sound structure of the tooth.

4) **Scattering:**

5) Unwanted tissue injury could occur, if heat is transmitted to the tissue through scattering at the surgical site.



PHOTOBIOLOGIC EFFECTS OF LASER

1. Photothermal effect
2. Photochemical effect
3. Photoacoustic effect.

1) **Photothermal Effect**

The principle effect of laser energy is photothermal, i.e. the conversion of light energy into heat.

The physical change in target tissue achieved through heat transfer is termed photothermolysis. This is further subdivided, subject to temperature change, phase transfer and incident energy levels, into photopyrolysis, photovaporolysis and photoplasmolysis.

Photopyrolysis:consistent with ascending temperature change from 60°C to 90°C, target tissue proteins undergo morphologic change, which is predominately permanent.

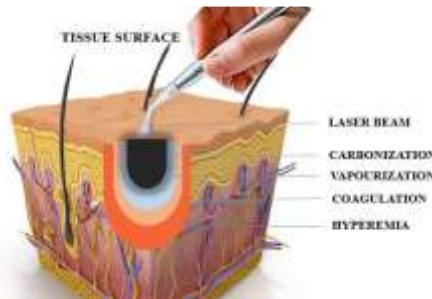
Photovaporolysis:at 100°C, inter and intracellular water in soft tissue and interstitial water in hard tissue is vaporized. This destructive phase transfer results in expansive volume change, which can aid the ablative effect of the laser by dissociating large tissue elements, especially seen in laser use in hard dental tissue cutting.

Photoplasmolysis:it is achieved photonically in soft tissue and thermionically in hard tissue and is characterized by fl ashes and popping sounds during laser use. Plasma formation can be beneficial, in that extremely high ablative energies can be produced, but also disruptive in that it can ‘shield’ the target from further incident light, through the phenomenon of a plasma acting as a ‘super-absorber’ of electromagnetic radiation. It is considered that, within therapeutic levels of laser power used in dental procedures, photoplasmolysis is a rare occurrence.

The photo thermal effects of laser energy on the target tissue are shown in

Tissue Temperature	Observed Effect	Applications
37–50°C	Hyperthermia i.e. tissue temperature is elevated above normal temperature but is not destroyed.	Photobiostimulation
60–70°C	Coagulation (irreversible damage to tissue, congealing liquid into a semi-solid mass)	Coagulation produces hemostasis by contraction of the vessel wall Protein denaturation is useful

	Photopyrolysis- Protein denaturation without any vaporization of the underlying tissue. The tissue whitens or blanches	in surgically removing diseased granulomatous tissue leaving the underlying healthy tissue intact
70–80°C	Welding of tissue i.e. adherence or stickiness of layers of soft tissue due to the helical unfolding of the collagen molecules and their intertwining with adjacent segments	Approximation of soft tissue edges
100–150°C	Photovaporolysis - Vaporization/ablation (vaporization of water within the target tissue) Spallation- refers to the microexplosion of the apatite crystals due to the vaporization of water from within the hard tissue resulting in a jet of steam that expands and then explodes the surrounding matter into small particles.	Ablative effect of lasers -excision of soft tissue commences at this temperature because of the high content of water in the soft tissues -Hard tissue cutting
>200°C	Carbonization - i.e dehydration and burning of tissue in the presence of air resulting in carbon as the end-product. Heat sink, collateral thermal trauma – on continuous laser application above 200°C the surface carbonized layer prevents normal tissue ablation by absorbing the incident beam causing heat conduction collaterally to a wide area.	



2) Photochemical Effect

The laser light can stimulate chemical reactions (e.g. curing of composite resin) and breaking of chemical bonds (e.g. using photosensitized drugs exposed to laser light to destroy tumor cells, a process called photodynamic therapy).

3) Photoacoustic effect

The pulse of laser energy on a crystalline structure (e.g. dental hard tissues) can produce an audible shock wave, which could explode or pulverize the tissue with mechanical energy creating an abraded crater. This phenomenon is called the photoacoustic effect of laser light.

CLASSIFICATION OF LASERS

According to ANSI and OSHA standards lasers are classified as:

Class I: These are low powered lasers that are safe to use. e.g. Laser beam pointer

Class II: Low powered visible lasers that are hazardous only when viewed directly for longer than 1000 seconds, e.g. He-Ne lasers

Class II b: Low powered visible lasers that are hazardous when viewed for more than 0.25 seconds.

Class III a: Medium powered lasers that are normally hazardous if viewed for less than 0.25 seconds without magnifying optics.

Class III b: Medium powered lasers that can be hazardous if viewed directly.

Class IV: These are high powered lasers (> 0.5 W) that produce ocular skin and fire hazards.

IMPLEMENTATION IN PROSTHETIC DENTISTRY

1. IN FIXED PROSTHETICS

- a. **Crown lengthening:** Clinical scenarios where crown lengthening methods are specified within esthetic zone, need attention to attain esthetic results. Crown lengthening methods with the help of lasers are included in following situation:
- Caries at gingival margin
 - Cuspal fracture extending apically to the gingival margin
 - Endodontic perforations near the alveolar crest.
 - Insufficient clinical crown length.
 - Difficulty in a placement of finish line coronal to the biological width.
 - Need to develop a ferrule.
 - Unaesthetic gingival architecture.
 - Cosmetic enhancements.

Lasers offer unparalleled accuracy and operator control and may be helpful for finely tracing incision lines and shaping the desired gingival margin outline. All the other crown lengthening methods has disadvantages in surgical approach healing time is longer, post healing gingival margin position is doubtful and patient compliance is poor as it needs use of anesthesia and scalpel for electro-surgery, the heat liberated has effect on pulp and bone leading to pulp death or bone necrosis.

- b. **Soft tissue management around abutments:** Argon laser energy has peak absorption in hemoglobin, thus, providing excellent hemostasis and well regulated coagulation and vaporization of oral tissues. These characteristics are beneficial for retraction and hemostasis of the gingival tissue in preparation for an impression during a crown and bridge method. Argon laser with 300 um fiber, and a power setting of 1.0W, continuous wave delivery, and the fiber is placed into the sulcus in contact with the tissue. In a sweeping motion, the fiber is moved around the tooth. It is dominant to contact the fiber tip with the bleeding vessels. Provide suction and water spray in the field. Gingivoplasty may also be done using argon laser.
- c. **Modification of soft tissue around laminates:** The removal and re-contouring of gingival tissues cover can be easily efficient with the argon laser. The laser can be used as a primary surgical instrument to detach excessive gingival tissue, whether diseased, secondary to drug therapy or orthodontic treatment. The laser will detach tissue and supply hemostasis and tissues join the wound.
- d. **Osseous crown lengthening:** Like teeth mineralized matrix of bone contains mainly of hydroxyapatite. The water content and hydroxyapatite produce for the high absorption of the Er: YAG laser light in the bone. Er: YAG laser has potential for bone ablation.
- e. **Formation of ovate pontic sites:** For favourable pontic design recontouring of soft and bony tissue may be needed. Soft tissue surgery may be performed with any of the soft tissue lasers and osseus surgery may be performed with erbium family of lasers.
- f. **Altered passive eruption management:** Lasers can be easily to control passive eruption problems. When the patients have clinical crowns that appear too short or when they have a jagged gingival line creating an uneven smile, excessive tissue can be detached without the need for blade incisions, flap reflection, or suturing.
- g. **Laser troughing:** Lasers can be used to create a trough around a tooth before impression taking. This can entirely replace the need for retraction cord, electrocautery, and the use of hemostatic agents. the results are predictable, efficient, minimize impingement of epithelial attachment, cause less bleeding during the subsequent impression , reduce postoperative problems, and reduce chair time³. It alters the biological width of gingiva. Nd:YAG laser is used.

- h. Bleaching:** Esthetics and smile are main situation in our modern society. Bleaching of teeth can be achieved in the Dental OPD. Diode lasers are used to bleach teeth without causing much tooth sensitivity and modification of the complexion of the tooth.
- i. Veneer removal :** With laser technology, the restoration can now be removed without cutting it off. The laser energy passes through porcelain glass unaffected and is absorbed by the water molecules present in the adhesive. It appears that this debonding occurs at the silane– resin interface because the underlying tooth structure appears to be unaffected.
- j. Crown fractures at the gingival margins:** Er: YAG or Er, Cr: YSGG lasers can be moved out to permit correct exposure of the fracture margin.
- k. To treat dentinal hypersensitivity:** There are many theories to describe the mechanism of hypersensitivity, but all conclude that open dentinal tubules are the path of stimuli to elicit response. The first laser use for the treatment of dentine hypersensitivity was reported by Matsumoto et al (1985) using Nd: YAG laser. Many of the lasers investigated can induce significant thermal effects, if laser parameters are inadequately controlled, giving rise to concerns regarding thermal damage to temperature sensitive pulpal tissue.
- l. Tooth Preparation:** Tooth preparation with lasers a debated topic still. There are no conclusive studies yet showed the use of lasers for crown preparation purposes. Er, Cr: YSGG laser is used most commonly now. But still some commercial companies say that they can be used. The following is the details what these companies say:
- It uses hydrokinetic technology (laser-energized water to cut or ablate soft and hard tissue). Because of this mechanism local anesthesia is not required in many cases, making this more comfortable procedure for the patient, and of course, saving time and anesthetic use by the patient.
 - The laser hand piece resembles a high-speed hand piece but with fiber-optic tips instead of a bur, which directs the laser energy at a focal point approximately 1-2 mm from the tissue surface.
 - The crown preparation should be started on maximum setting for cutting enamel (6W,90% air,75% water),started with a defocused mode for 30 seconds to 1 min for anesthesia of tooth.
 - While placing the gingival margin setting will be reduced 1.25 W, 50% air, 40% water to control the cutting tip, for the purpose of accuracy.
 - To finish with the interproximal, buccal, lingual/palatal reduction cuts will be performed with the dentin settings 4W, 65% air, 55% water.
 - The laser has to be reset at 2.25 W, 65% air, 55% water to finish the buccal cusp overlay, and the final Margination of the proximal and lingual surfaces.

Advantages:

- For vital crown preparation no need of local anesthesia, as laser causes temporary paresthesia
- of nerve endings.
- Procedure is accurate and faster than the conventional method.

Disadvantages:

- Trained dentist required the particular use.

2. IN REMOVABLE PROSTHETICS

Lasers may now be used to perform most pre-prosthetic surgeries. These methods involve hard and soft tissue tuberosity reduction, torus removal, and treatment of inappropriate residual ridges involving undercut and irregularly resorbed ridges, treatment of unsupported soft tissues, and hard and soft tissue malformation. Lasers may be used to treat the problem of hyperplastic tissue and nicotinic stomatitis under the palate of a full or partial denture and ease the irritation of epulis, denture stomatitis, and other problems related with long term wear of ill-fitting dentures. Stability, retention, function, and esthetics of removable prostheses may be increased by proper laser manipulation of the soft tissues and underlying osseous structure.

- a. **Treatment of unsuitable alveolar ridges:** Alveolar resorption usually is uniform in vertical and lateral dimensions. To smooth the residual ridge soft tissue lasers surgery to expose the bone may be performed with any number of soft tissue wavelengths (CO₂, diode, Nd:YAG,) Hard tissue surgery may be performed with the erbium family of wavelengths.
- b. **Treatment of undercut alveolar ridges:** There are many causes of undercut alveolar ridges. Naturally occurring undercuts such as those found in the lower anterior alveolus or where a prominent pre-maxilla is present may be the cause of soft tissue trauma, ulceration, and pain when prosthesis is placed on such a ridge. Soft tissue surgery may be performed with any of the soft tissue lasers. Osseous surgery may be performed with the erbium family of lasers.
- c. **Treatment of enlarged tuberosity:** The most common reason for enlarged tuberosities usually is soft tissue hyperplasia and alveolar hyperplasia accompanying the over-eruption of unopposed maxillary molar teeth. Surplus soft tissue should be excised, allowing room for the denture bases. The soft tissue reduction may be performed with any of the soft tissue lasers. Erbium laser is the laser of choice for the osseus reduction.
- d. **Surgical treatment of tori & exostoses:** Prosthetic problems may arise if maxillary tori or exostoses are large or irregular in shape. Soft tissue lasers may be use to expose the exostoses and erbium lasers may be use for the osseous reduction. A smooth, rounded, midline torus normally does not create a prosthetic problem because the palatal acrylic may be relieved or cut away to avoid the torus.
- e. **Soft tissue lesions:** Persistent trauma from a sharp denture flange or over compression of the posterior dam area may produce a fibrous tissue response. Hyperplastic fibrous tissue may be formed at the junction of the hard and soft palate as a reaction to constant trauma and irritation from the posterior dam area of the denture. The lesion may be excised with any of the soft tissue lasers and the tissue allowed to re- epithelializes.
- f. **Laser welding:** One of the modern methods of removable partial dentures defect repairs uses the pulsed laser with relative low average out power. This is known as a precise and rapid joining method, but its success depends on the control of many parameters.
Eg: For Co-Cr alloy frameworks: The welding parameters were determined for each defect type and working step (fixing, joining, filling, planning).Adequate combination of pulse energy (6-14 J), pulse duration (10-20 ms) and peak power (600- 900 W) depending on the working stage improves the success of the welding procedure.

3. IN COMPLETE DENTURE PROSTHETICS

- a. **Prototyping & CAD/CAM Technology:** The term rapid prototyping (RP) refers to a class of technologies that can automatically construct physical models from Computer-Aided Design (CAD) data. These “three dimensional printers” allow designers to quickly create tangible prototypes of their designs, rather than just two-dimensional pictures. Such models have numerous data. In addition to prototypes, RP techniques can also be used to make tooling (referred to as rapid tooling) and even production-quality parts (rapid manufacturing).A software package slices the CAD model in to a number of thin (eg.0.1mm) layers, which are then built up one atop another. Rapid prototyping is an additive process, combining layers of paper, wax, or plastic to create a solid object. In contrast, most machining processes (milling, drilling, grinding, etc.) are “subtractive” processes that remove material from a solid block. RP’s additive nature allows it to create objects with complicated internal features that cannot be manufactured by other means.
- b. **LASER rapid forming of a complete titanium denture base plate:** This technique uses the combination of the CAD/CAM and LRF (Laser Rapid Forming) methods for forming the titanium plate of a complete denture. Laser scanner, reverse engineering software, and standard triangulation language (STL) formatted denture base plate and sliced into a sequence of numerical controlled codes. The denture plate will be built layer-by-layer, on the LRF system. After the traditional finishing techniques, this denture plate will be acceptable for use in patients.

- c. **Study of complete denture occlusion using by three-dimensional technique:** After fabrication of new dentures the occlusion can be examined and studied with the help of laser scanner technique and three-dimensional reconstruction. The relationship between the parameters of balanced occlusion can also be analyzed.
- d. **Analysis of accuracy of impression by laser scanner:** The scanning laser three-dimensional (3D) digitizer can delineate x, y, and z coordinates from a specimen without actually contacting the surface. The digitizer automatically tracks coordinates with precision and stores data as the number of points on a surface with a resolution of 130 mm at 100 mm. These exacting features suggest that the laser digitizer might accurately and reliably measure the dimensions of dental impression materials while avoiding subjective errors. The image is built up and landmarks identified which allow superimposition of the images and so enable the differences between two similar images to be calculated. The 3D laser captures complex 3D texture-mapped models and they are exported into a 3D (Scan Surf) software application where it is built and triangulated into a 3D meshwork image of the object. The scanning process is accomplished within a minute whereas the software analysis takes much longer. The software superimposes the two objects by either registering landmarks or by registering as iterative closest point (ICP). This finds an optimal fit between the two surfaces and in effect acts as a reference area. Once superimposed, the difference of the two surfaces is calculated as the shortest distance of each point on one object surface from a second object surface, within a range of 0.5 mm. Three-dimensional digitizers will eventually become less expensive, require less maintenance, track faster, and be available with more standardized software.

4. IN IMPLANT DENTISTRY

- a. **For sterilization of socket:** In immediate implant dentistry after extraction of tooth, without any infection, socket can be sterilized immediately without any pain.
- b. **Implant site preparation:** The removal of the overlying structure at implant site leads to fast healing time, better integration, minimal patient discomfort, better visibility at the placement site and more bone to implant contact. It can also be used in patients with potential bleeding problems, to provide essentially bloodless surgery in the bone.
- c. **Second stage uncovering:** CO₂ laser and almost all types of lasers are used to remove overlying soft tissue. Immediate impression can be taken after second stage surgery due to its hemostatic effect and the minimal retraction of peri-implant soft tissues after laser surgery, which ensures that tissue margins remain at the same level after healing as they are immediately after surgery.
- d. **In case of peri- implantitis:** Since the laser does not transmit damaging heat, it can be utilized to vaporize any granulation tissue as well as clean the implant surface in peri-implantitis cases. This procedure eliminated the acute state of peri-implantitis, resulting in positive GTR, and allowing the patient extended use of the implant. Nd: YAG and Ho: YAG lasers are not suitable for the treatment of peri-implantitis and cause fusion, loss of porosity and other surface Alterations.
- e. **Removal of diseased tissue around the implant:** Lasers can be used to repair ailing implants by decontaminating their surfaces with laser energy. Diode, CO₂ & Er:YAG lasers can be used for this purpose. Lasers can also be used to remove granulation tissue in case there is inflammation around an already osseointegrated implant. Laser ablation using the Er: Cr: YSGG laser is highly efficient at removing potential contaminants on the roughened implant surface while demonstrating no effects on the titanium substrate.
- f. **Sinus lift procedure:** Lasers can also be used in the sinus lift procedure. The procedure can be done by making the lateral osteotomy with a decreased incidence of sinus membrane perforation. The yttrium-scandium-gallium-garnet (YSGG) laser is the optimal choice for not cutting the sinus membrane. The YSGG laser can also be used to make the osteotomy for a ramal or symphyseal block graft. Bone grafts done with lasers have been demonstrated to decrease the amount of bone necrosis from the donor site and the osteotomy cuts are narrower, resulting in less postoperative pain and edema.

5. IN MAXILLOFACIAL PROSTHESIS

New advances in rapid prototyping technologies have demonstrated significant advantages compared to more conventional techniques for fabricating facial prosthesis. The use of selective laser sintering technology is an alternative approach for fabricating a wax pattern of maxillofacial prosthesis. This new approach can generate the wax pattern directly and reduce labor-intensive laboratory procedures.

SLS (Selective Laser Sintering): The SLS is a method of computer aided designing using mainly the laser. In this method models are generated directly from 3-D computer data then converted to STL files, which are then sliced in to thin layers (typically about 0.1 mm/0.004 inches) using the associated computer software. The laser sintering machine produces the models on a removable platform by applying incremental layers of the pattern material. For each layer, the machine lays down a film of powdered material with an accurate required thickness, again a fresh film of powder is laid down, and the next layer is melted with exposure to the laser source. This process continues, layer by layer, until the pattern is completed.

Advantages:

- Manufacturer time is reduced.
- More precision can be achieved.

6. LASER APPLICATIONS IN THE DENTAL LABORATORY

Lasers have been used for deposition of hydroxyapatite (HA) thin films on titanium implants. pulsed laser deposition (PLD) has proven to be a promising method to produce pure, crystalline and adherent HA coatings which show no dissolution in a simulated body fluid. Use of lasers for surface treatment of titanium castings for ceramic bonding have shown improved bond strength when compared to acid etching techniques which are commonly used. Lasers can also be used for welding.

DENTAL LASER SAFETY

According to the CDRH and ANSI system of classification, class 4 lasers are defined as those devices that pose a biologic hazard from either direct or diffuse reflection.

CLASS	DESCRIPTION
I	Very low risk "safe under reasonable foreseeable use"
IM	Wavelength between 302.5 nm and 4000nm and are safe except when used with optical aids (e.g. binoculars)
II	Do not permit human access to exposure levels beyond the Class 2 AEL (Accessible Emission Limit) for wavelength between 400nm and 700nm
IIM	Have wavelength between 400nm and 700nm and are potentially hazardous when viewed with an optical instrument
IIIR	Range from 302.5 nm and 106nm and is potentially hazardous but the risk is lower than that of Class IIIB lasers
IIIB	Normally hazardous under direct beam viewing conditions, but are normally safe when viewing diffuse reflections
IV	Hazardous under both intra beam and diffuse reflection viewing conditions. They may cause also skin injuries and are potential fire hazards.

Risks Associated with Laser use

i. Laser Beam Risks

These risks are those that are posed by exposure of non target tissues to laser beams. Because of the intensity of the output beam and the ability of lasers to produce very high concentrations of optical power at considerable distances, these lasers can cause serious injuries to the eyes and can also burn the skin.

Optical Risks:

The majority of laser-induced ocular injuries are considered due to operator error.

- Wavelengths from 400–1,400 nm (visible and nearinfrared) can pass through the transparent structures in front of the eye and impact on the retina.
- Longer wavelengths (2,780–10,600 nm, mid-tofarinfrared), will interact with the cornea.

- Longer wavelengths will interact with structures at the front of the eye; causing ablation, scarring and distortion of vision Non-pigmented structures towards the front of the eye will be most at risk from longer wavelengths.

Skin Risks:

Whilst ultraviolet lasers (<400 nm) are not commercially used in dentistry, there is a combined risk of ablative damage to skin structure and possible ionizing effects that may be precancerous. All other laser wavelengths can cause 'skin burns' due to ablative interaction with target chromophores.

ii. Non-beam Risks

These risks are associated with possible physical damage arising from:

- Moveable components of a laser, electrical shock and mains supplies (pressurized air, water).
- Fire risks, through the ignition of tubing, some anesthetic gases or chemicals (e.g. alcoholic disinfectants), should be identified and avoided.
- The products of tissue ablation, collectively termed a 'laser plume' represent a considerable hazard that can affect the clinician, auxiliary personnel and the patient. Whenever non-calcified tissue is ablated, such as in caries removal and all soft tissue surgery, a complex chemical mixture is emitted. This may include water vapor, hydrocarbon gases, carbon monoxide and dioxide and particulate organic material (including bacteria and viral bodies). The effect of plume inhalation can be serious and cause nausea, breathing difficulties and distant inoculation of bacteria. The plume arising from mid-infrared wavelength ablation of dental hard tissue is comparatively less potentially dangerous and can be considered similar to the debris that is produced with an air turbine.

Laser Safety Measures

Safety measures applicable to laser use in dental practice meeting the worldwide standards can be listed as follows:

1. Access

During laser treatment, only the clinician, assistant and patient should be allowed within the controlled area. Door locks and warning lights can be activated during laser emission. Those dental clinics that operate a multichair, open-plan environment would need to address the requirement in greater detail.

2. Laser Safety Features

All lasers have in-built safety features that must be cross matched to allow laser emission. These include:

- ✓ Emergency 'Stop' button
- ✓ Emission port shutters to prevent laser emission until the correct delivery system is attached
- ✓ Covered foot-switch, to prevent accidental operation
- ✓ Audible or visual signs of laser emission
- ✓ Key or password protection
- ✓ Remote inter-locks

3. Eye Protection

All persons within the controlled area must wear appropriate eye protection during laser emission. It is considered advisable to cover the patient's eyes with damp gauze for long wavelength perioral procedures.

4. Test Firing

Prior to any laser procedure and before admitting the patient, either the clinician or laser safety officer should test-fire the laser. This is to establish that the laser has been assembled correctly, is working correctly and that laser emission is occurring through the delivery system. The laser is directed towards a suitable absorbent material, e.g. water for long wavelengths and dark colored paper for short wavelengths, and operated at the lowest power setting for the laser being used. Following this, the laser is inactivated and the patient admitted.

5. Training

All staff members should receive objective and recognized training in the safety aspects of laser use within dentistry, as with other specialties. However, there is no legal obligation for this.

CONCLUSION

Laser has become a ray of hope in dentistry and its role in prosthodontics has increased the success rate of prosthesis and helps in restoring form, function and esthetics of the patients. Lasers when used efficiently and ethically, it provides excellent results with its own limitations. Thus, with newest ongoing researchers, the future of dental laser became bright in reforming many smiles. Laser forms a boon to many patients with bleeding disorders or allergies and also to the dentist in performing surgeries as it provides a pain free care. Besides being a “state of art” gadget, laser is extremely useful and patient friendly piece of equipment for the dental professionals.

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