INVITED REVIEW


Hard tissue lasers: An insight

Rajesh Pillai, U-Nu Sujathan, Asha Sarah Jacob, Afzal Abdulsalim, Shan Sainudeen
Department of Conservative Dentistry and Endodontics, P.M.S College of Dental Science and Research, Golden Hills, Vattappara, Trivandrum, Kerala, India

Correspondence Address:
Rajesh Pillai
Department of Conservative Dentistry and Endodontics, P.M.S College of Dental Science and Research, Golden Hills, Vattappara, Trivandrum, Kerala, India

Abstract

Origin of light amplification for stimulated emission of radiation (LASER) had its roots way back in 1960 when Maiman invented the first hand held ruby laser. LASER is the common acronym used for LASER. Current scientific review has touched various aspects like the historical landmarks, luminaries behind several landmarks in the invention of lasers in a chronological order, hard tissue lasers along with dental operating microscope and magnification have made practice of restorative and microsurgery facile and due to its versatility have found numerous applications extending to almost all spheres of restorative dentistry and minor oral surgery. Owing to its profound advantages such as reduced anxiety to drill phobic patients, excellent predictability, and uneventful postoperative healing have urged modern dental surgeons to embrace laser technology aggressively. This review addresses hard tissue laser physics, protocols and parameters and clinical applications and tips. Clinical Relevance To Interdisciplinary Dentistry

- Erbium lasers have increased affinity for basic chromophores like water and hydroxyapatite crystals. This affinity makes these lasers suitable for various restorative clinical procedures involving both hard and soft tissues. They are a valuable adjunct in:
- Tooth preparation for restorative procedure, etching of enamel, relative analgesia, disinfection of root canal lumen and they can also effectively disinfect enamel up to 300–400 μm
- Periodontal surgical procedures such as gingivectomy, gingivoplasty, frenotomy, osseous recontouring and removal of subgingival calculus
- Crown lengthening, tooth preparation, implant osteotomy, recovery of implants, effective disinfection of periimplantitis, creating positive bony architecture etc.

Full Text

DATE LINE OF DENTAL LIGHT AMPLIFICATION FOR STIMULATED EMISSION OF RADIATIONS

Ideology of laser technology can be traced back to 1913 when Neils Bohr introduced the spontaneous emission theory for which he was privileged with the Nobel prize. Albert Einstein had worked comprehensively on the study on quantum theory of physics on discharge and assimilation and outlined the theory on stimulated emission of radiation "Zur Quantum Theorie der Strahlung." [1] This probe into the fascinating ray of light earned him the Nobel prize in 1921. He had visualized that photoelectric spiraling could discharge a single rate of repetition of the energy wave having a common wavelength, explains how a laser unit functions.

The credit of developing the laser equipment goes to Maiman. He developed a pulsed ruby laser with a rod inserted into a photographic flash lamp in 1960, which came to be referred as "light amplification by stimulated emission of radiation (LASER)," the first device relentlessly referred by the acronym LASER. [2] Other major landmarks in the development of laser are enumerated in [Table 1]. (Table 1)

BASIC LASER COMPONENTS

Components

Basic components of a hard tissue laser are controller, active medium and pumping source, optical cavity, optic fibre and hand piece [Figure 1].

(Figure 1)

The control panel is like a computer input device, which in turn connected to a microprocessor that will authorize the mandatory power settings and yield working parameters [Figure 2].

(Figure 2)

Active medium and pumping source

Active medium can be solid crystal of yttrium scandium gallium garnet (doped) with erbium and chromium (Er, Cr: YSGG) and crystal of yttrium aluminium garnet doped with erbium, contains a homogenous population of atoms, on receipt of stimulation from the pump source, inversion of polarization occurs once light passes through the active medium several times, around 10-15% of the available energy is dissipated as heat and guideline of temperature is governed by the inherent cooling subsystem.

Erbium family of lasers enjoy a strobing flash lamp which emits exceedingly short pulses in the range of microseconds (10–6), constantly referred to as free running pulsed mode of emission, because of the short peak time.

Optical cavity

Optical cavity houses the laser medium and pumping energy source. It has analogous mirrors on either end of the cavity permitting photons exiting the medium to be reflected back...
through the medium several times leading to the creation of a collimated, coherent and a monochromatic beam of light. Laser light exits the resonator, after bouncing back and forth flanked by two mirrors, one totally reflective and the other in some measure reflective, through the delivery fiber to the tip of the handpiece and ablate. [3]

Optic fibers

Mid-infrared lasers can be transmitted all the way through ample diameter optic fiber bundles or hollow wave guide attached to handpieces with tips made up of sapphire or fluoride glass. Superness delivery system ensures healthier transmission and a better access even to the posterior regions. The disadvantage is the concluding wear of the sapphire tips like the diamond abrasive points ensuing in partial loss of energy at some point in energy delivery through the articulated arms. Erbium handpieces are equipped with terminal mirror and tips to transfer photon energy to the surgical site. [3]

Hand piece

The delivery point of Laser energy to tissue surface.

Glossary of terms in laser dentistry

Ablation: Lasers ability to cut, vaporize and coagulate utilizing thermal energyPower: Energy pulse multiplied by the recurrence frequency (pulses per second)Power (W) = Energy (J) × repetition rate (Hz)Peak power: Contrariwise proportional to the pulse duration, shorter the pulse width the higher the peak powerPeak power (W) = Energy (J)/pulse duration (s)Power density: Average focus of photonic energy deposited over a specific area, normally calculated by the power used for unit surface of the tip expressed in W/cm 2 by the period of a single impulse (microseconds); by the instance taken for thermal relaxation time (microseconds) and by the modality of emanation of energy say for example pulsed or super pulsed modeFluence or energy density: Accessible energy per unit surface frequently expressed in J/cm 2 Pulse width: Duration of the pulses of the laser beam, deliberated in nano, pico or femtoseconds (10−9, 10−12, 10−15) Ablation threshold: Intensity of energy required to take water in the tissue to boiling and to provide the energy for phase transformation from a liquid to gas. Ablation threshold for enamel is 12-20 J/cm 2 in erbium doped yttrium aluminum garnet (Er: YAG) lasers and for Dentin is 8-14 J/cm 2 as in the case of Er,Cr: YSGG lasers

Peak power is calculated by dividing the energy for the pulse by the energy duration. Average power is the amount of sustainable energy delivered over a precise period of time of an erbium unit Pulse duration: Length of the pulse, shorter the pulse the larger the zenith of power, longer the pulse higher will be the thermal effects materialization on the tissue substratePulse profile: Length of the single impulse, steeper the rise of the single pulse, the sooner the rise in temperature.

LASERS IN THE MID-INFRARED SPECTRUM OF LIGHT

Erbium family of lasers

Erbium family comprises of Er, Cr: YSGG and Er: YAG lasers. Er: YAG is a solid active medium where a pure crystal of yttrium aluminum and garnet is intentionally doped with erbium atoms. [3] On prompting the active medium releases photons in the scope of 2.940 nm. Er: Cr: YSGG laser constitutes a solid active medium - a crystal of yttrium, scandium, gallium and garnet doped with atoms of erbium and chromium. Erbium lasers underline the following features like:

- Pulse duration of 50-1000 μs
- Handpiece can be small, large, straight, angled, contact or noncontact handpiece
- Air - Water spray.

Different mechanisms do exist in delivering the laser energy through the handpiece e.g.:

Articulated arm

Optical fiber

Hollow fiber.

Largely the hard tissue lasers are equipped with a handpiece with a terminal mirror and tips which serve as outlets to deliver the cascade of photons to the tissue being targeted. Present day handpieces are multipurpose and ergonomic. Improved delivery of energy of photons can be achieved along with the air-water spray if the handpiece is coaxial to the laser beam. Coaxial existence of air-water enables better delivery of laser energy as well as enhanced cooling and cleansing action.

FAR CONTACT HANDPIECE

Terminal part of the handpiece houses a unique lens which focuses the laser beam from the target tissue at a distance of 5-15 mm where you clinically observe clinically observable ablation threshold but reduced tactile sensation.

CLOSE CONTACT HANDPIECE

Handpiece functions with tips of varying diameter, length, and proclivity to interact with the substrate. Nearer the tip to the substrate better will be the exactness. Demerits of these handpieces are vulnerability, abridged competence via wear of the tips as well as unbalanced loss in energy while traveling the target.

ADVANTAGES OF ERBIUM LASERS

Diminution of bacteria

There is a marked decrease in microorganisms in laser tooth preparations when compared with traditional mechanical techniques. Hibst et al., [3] verified that bacteria were thoroughly inactivated throughout laser ablation up to a depth of 300-400 μm. [4] Energy levels of 75 mJ can cause unalterable damage to bacterial cell wall consequently shifting the osmotic gradient accelerating swelling intracellularly culminating in cell death.

Lowest rise in temperature

Krmek et al. found the highest rise in temperature in the pulp was achieved with the premier energy used on the enamel (400 mJ and 15 Hz) and the lowest rise in temperature with the lowest energy (320 mJ and 10 Hz). Mean rise in temperature was only maximum of 1.96°C ± 0.29°C to a minimum of 0.7°C ± 0.1°C. [5] Temperature scrutiny on dentin gave interpretations of at most temperature increase was achieved with 340 mJ and 10 Hz (1.37°C ± 0.42°C) and lowest temperature generation was noted with 200 mJ and 5 Hz (0.43°C ± 0.18°C). [5]

Macro and microroughened surface

Mid infrared radiation simulates a macro and microroughened surface similar to that induced by 37% phosphoric acid suitable for adhesive restorations. Parameters to be considered are not only Fluence and Power Density but familiarity with the beam profile, volume of water spray and pulse duration also. Radiation with Er: YAG lasers at 250 mJ and 25 Hz (fluence of 88 J/cm 2 ) and Er, Cr: YSGG laser at 275 mJ and 20 Hz (fluence of 97 J/cm 2 ) demonstrates a clean surface, homogenous layer of wrinkled enamel with sulci, flakes and shelves. [6]

Kind interaction with bone

Ossous removal is facilitated due to the wavelengths kinship for the ossous tissue and water especially in the bone, and surgical site. Erbium lasers can be used successfully in restorative dentistry since carious lesion in close proximity to the gingiva can be treated and sculpting of the soft tissue can be achieved simultaneously. Tissue revealing for second stage implant recovery is safe as minimal heat is transferred to the surrounding bone.
Disadvantages of erbium lasers

Manual finishing of the preparation margins

Irradiated prisms are rather frail, might necessitate manual finishing of the margins with rotary burs or polishing discs to remove unsupported enamel prisms and to strengthen marginal integrity. [7]

Reduced adhesion to dentin

On lasing dentin collagen fibers can become mixed-up progressing to reduced adhesion and shear bond strength. Water is completely vaporized especially in the intertubular dentin accompanied by propagation of cracks, fusion with signs of glazing and denatured collagen. [7]

Hemostasis ability is inadequately owing to less significant penetration nor continual heat to set off blood vessel shrinkage.

TARGET TISSUE

Basic chrophomeres having likeness to Er: YAG is water and for Er, Cr: YSGG is hydroxyapatite. They present in varying percentages in the soft and hard tissues. Contrasting the physiologic status water occupies an elevated volume in decayed tissues (24-55% by volume), also in attendance in soft tissues as high as 80% by volume with allocation in the interprismatic enamel constituent 12% by volume and that in the intratubular and pentalular structures as high as 24% by volume [3] erbium family of lasers are ideal for use when the target tissue is in some gauge vascularized and is rich in fibrotic component e.g.: Fibrotic lesions, labial and lingual frenum, gingivectomy, gingivoplasty, opercoulectomy and gingival depigmentation.

Interaction with hard tissues

Treatment with erbium family of lasers is linked to the convey of laser energy to the substrate inducing thermal and thermo mechanical phenomena. Owing to its high empathy for water intrinsic water bound to the crystalline structures absorbs the laser energy. This interaction results in minimal reflection (1-3%) and minimal diffusion and transmission resulting in superficial ablation [Figure 3]. [Figure 3]

Penetration depth on enamel and dentin for Er, Cr: YSGG and Er: YAG lasers are 20 μm and 5 μm respectively and generally transparent protective glasses are worn by the operator unlike the pigmented glasses worn by the operator while working on diode lasers.

Primarily on the erbium energy is absorbed by the water molecules in tissues, it is enhanced to heat causing superheating culminating in a micro explosive growth when the water vaporizes and reaches steaming point. Ablation is manifested as a result when the tissue exceeds the structural strength of the overlying material.

At the secondary level effect can transpire a good deal below the melting point of enamel, a shock wave provokes a disruptive volume expansion and a colloidal subsurface pressure arises prompting the surrounding enamel matrix to be worn to shreds. This eviction of fractured inorganic matrix of the tooth is directly proportional to the presence of water in these tissues. Privileged the water content, more swift will be the rate of ablation.

Supply of extrinsic water spray prevents surplus heat build-up of the tooth, charring and nevertheless maintains a hygienic tooth surface to modulated energy blocks to block unwanted structural thermal changes. A study by Ollivi et al. concluded that safer and more effective radiation was found at higher percentages of water and air (Er, Cr: YSGG 80% and 92%: 56 mL/min). [8]

Laser energy must be decreased during ablation of healthy and carious dentin as both possess higher water content than enamel. Singular precaution must be exercised in functioning very close to the pulp chamber owing to the high water content, it requires less energy for vaporization of pulp with erbium laser energy.

Primary teeth to ablate require less quantum of energy owing to thinner layer of enamel and higher water content. In deciduous teeth enamel prisms are large, irregular and often have a superficial layer of apsimatric tissue, generally giving a whitish appearance to primary teeth making them opaque.

Dental tubules are smaller in diameter, widely spaced with a lower number of dentinal tubules per unit area.

Erbium laser energy is also engaged by the hydroxyl group of hydroxyapatite found in enamel and dentin. Swiftness of ablation can be influenced by the incorporated content of fluoride and also the solidity of enamel and dentin.

ERBIUM DOPED YTTRIUM ALUMINUM GARNET LASER APPLICATIONS IN SOFT TISSUES

Epulis Disclosure of unerupted teethFibromaFrenectomyGingival hyperplasia and hypertrophyHerpes simplex i ulcersMucoceleOperculectomyPapillomatosisDirect and indirect pulp cappingRanulaSalivithesis of submandibular duct.

ERBIUM DOPED YTTRIUM ALUMINUM GARNET LASER APPLICATIONS IN HARD TISSUE

Laser analgesiaRemoval of impacted teethElimination of cariesCavity preparationSurface conditioning of enamel and dentinDebridement of inclined fissuresPreconditioning prior to sealant applicationSterilization of the pulp space.

CLINICAL APPLICATIONS

Laser analgesia

Ablation with a low energy near infrared radiation foregoing any surgical or nonsurgical procedure can kick off a pain-relieving or analgesic effect. Cell membrane of the nerve fibers experiences a transient loss of conductance of the impulse generated owing to hyperpolarization culminating in the interruption of the Na + /K + pump. As a result pain receptors allied to phobia to needles or the echo of drills. Laser handpiece is unhurriedly moved back and forth in a noncontact mode preparatory with low energy and little by little modulating the power in an upward gradient.

Erbiums laser energy will make a way along the hydroxyapatite crystals towards the dental pulp especially at pulse rates of 15-20 Hz and at pulse energies lower than the ablation threshold of tooth. Energy pulses correlates with the native bioresonance of type C and associated nerve fibers in the pulp. There is a threshold effect of the irradiation required to achieve maximum restraint, that’s why the analgesic effect of low level erbium laser therapy cannot be termed a numbing effect. [9]

Various laser analgesia techniques are:

Margoli’s technique
Anterior teeth

Erbium laser tip is held 4 mm from the tooth and run slowly across the facial surface of the tooth at 1.5 W for 30 s.

Posterior teeth

Laser tip is held 4 mm from the tooth and run slowly across the central groove of the tooth at 1.5 W for 15 s. If a metal restoration is present, the surface and cavity is concluded.

Oliv-Genovesi technique

Specifically indicated for Er:YSGG laser, owing to its condensed absorption in water and higher penetration depth through the gingiva into hard tissues as compared to Er:YAG Laser tip is held 6-10 mm from the tooth and run at a snail's pace across the neck of the tooth at the gingival cervix for 60 s at 25-50 mJ and 10-15 Hz with a low air-water ratio gradually mounting the energy to 75 mJ after the first 60 s primarily in a defocused mode, gradually escalating the pulse repetition rate up to 25 Hz and the energy and the air and water up to the bare minimum effective level.

Rabbit technique

Invariable ablation of the hard tissue on a high power setting of 3-4 W 60% water, 80% air, 15 Hz throughout the procedure. Tip is held 6-8 mm away from the target tissue aiming the laser energy toward the fissure. Maintaining the defocused distance, laser tip is moved back and forth slowly for 90 s. This defocused mode constantly supplies low energy to the pulp and induce analgesia. Subsequently tip is held 1-2 mm away from the tooth surface to commence ablation. On reaching dentin tip is retracted defocused to reduce the energy reaching the surface and cavity is concluded.

Turtle technique

Laser tip is held 1-2 mm away from the target tissue during the full clinical procedure. Initially, low energy settings are utilized and steadily increased until ablation is comprehensive and on reaching the dentin power settings are reduced to suit the comfort levels of the patient. [10]

Laser assisted sealants

On the application of amply high fluence erbium lasers could amend the enamel composition and perk up resistance to acid demineralization. Delbem et al. concluded that Er: YAG laser use following APF gel application prejudiced deposition of calcium fluoride in enamel enhancing resistance against the onslaught of caries. [11]

Apel et al. hypothesised that Er: YAG laser after receipt of subablative energies on enamel had shown an increase in resistance to acid from the diet and cariogenic bacteria. Chimelio et al. contrastingly reported that enamel subjected to cariogenic challenge, after cavity preparation with Er: YAG laser, examined under polarized light microscopy, ascertain no significant differences in demineralization, zone of inhibition and nonexistence of cracks in the inorganic matrix of enamel.

Researchers at University of Genoa by Steffano Benedicenti were of the opinion that Er: YAG in combination with acid etching had various benefits like:

- Fissure decontamination and cleansing
- Enhanced adhesion of sealant to enamel improved marginal integrity
- Longer retention of the sealant.

Desensitization of exposed dentin

Hypersensitive cervical dentine do respond positively to Er: YAG lasers, a dose of subablative energy with the following settings 0.1 W, 3 Hz, 20% air and no water spray have provided a sustained positive response from sensitivity following erbium therapy.

Class I cavity preparation

Laser tip is slanted 25° angle from the vertical and intenderd at the enamel fissure, once ablation commences tip is pointed to the opposite wall of the fissure and then directly 90° into the central groove which will make possible to deepen the cavity preparation. It is optional to finish the cavity preparation with a high speed diamond abrasive point and a final sweep with erbium laser to remove the smear layer. Evaluation of Knoop hardness number and ratio of calcium and phosphate ratio did not reveal any significant differences on comparing hard tissue laser treatment and routine cavity preparation with tungsten carbide burs.

Class II cavity preparation

Unlike the routine Class II preparation here the proximal box is prepared first. Laser tip is held right angle to the marginal ridge and a slow but sure back and forth all-inclusive motion is engaged from buccal to lingual to ascertain the proximal box, and occlusal extension is finished as Class I cavity preparation. Slighter power settings are employed once dentin is reached.

Class III, IV and V cavity preparations

Laser tip is held 4 mm away from the tooth and run unhurriedly across the facial surface at 1.5 W to 2 W for 30 s. after the first 30 s laser tip is brought within 1.5 mm of the carious lesion and ablation is commenced. Far contact handpieces held 3-4 mm away from the target site is moved around in a slow circular motion to improve patient comfort and prevent any iatrogenic mishaps. Once caries is removed, sophistication of the margins can be done with abrasive points, bevets placed, glass ionomer placed as a cavity lier and composite resin restorations are given with emphasis given on finishing and polishing and on the gingival response to the restorative material.

Indirect pulp capping

Predictability of pulp capping is superior in laser assisted procedures with disinfection attained up to a depth of 300 μm. Erbium energy is selective for carious tissue with ample water content and at the same time disinfects and smear layer is also removed. Reduced heat generation in the pulp chamber and accompanying laser analgesia makes supervision of local anesthesia not mandatory.

Direct pulp capping

In clinical surroundings when close by is a case of Iatrogenic pulp exposure, site is germ-free and free of caries, erbium laser therapy can be initiated in two phases, first round juncture of decontamination performed with Er, Cr: YSGG laser at 1 W, 20 Hz with 20% air and 15% water, in the later and final stage of attaining pulp coagulation water supply is absolutely cut off with the following parameters 0.5 W, 20 Hz, 20% air.

Pulpotomy

In the preliminary stage anesthesia is administered and rubber dam applied. Operator has to undoubtedly focused in the setting the parameters that is, an advanced energy for access cavity preparation, say 2-3 W, 20 Hz, 80% air, 60% water, followed by 1-1.5 W, 20 Hz and 150 mJ for vaporizing the diseased coronal pulp, despite the fact that continuous flow of water be maintained. Attenuated power and constant flow will safeguard the rest of the pulp to sustain the continued formation of the immature apex. 650 μm tips made of sapphire are preferred, duration of ablation will be 20 s for four duty cycles. To implement coagulation following amputation of the coronal pulp a reduced power setting of 30-40 mJ, tip of handpiece held at least 3-4 mm away in a defocused mode, devoid of water spray and only 30% air.

Pulp space therapy

Bactericidal facility of erbium family of lasers is nowhere close to that of diode lasers especially in disinfection of the pulp space, at best effective up to a depth of 300 μm limiting itself to the canal walls and not incisive deep in to the lateral or accessory canals. This property is chiefly by the ability to microcrystalline smear layer and complex ecosystem of biofilms attained by rinsing of the canal lumen.
Hard tissue lasers: An insight
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An in vitro study concluded that at low power settings of 1 W Er, Cr: YSGG had a competence ratio of 77% which is inferior as compared to diode lasers which had a triumph rate of 99.99% proven by Steffano Benedetti and coworkers at University of Genoa.

Ability to nullify the presence of Enterococcus faecalis was analyzed by Gordon et al. who validated that when a 200 μm tip was used for 2 min at 0.4 W and 20 Hz by moving the tip in a constant manner, after 4 mm of the working length had a high success percentage. Studies when reducing the power setting to 0.2 W and 20 Hz with air and water spray has reported 99.7% reduction in the pulp space flora.

Schoop et al. evaluated the mean increase in temperature on the peripheral root surface with the same mentioned parameters and found it to be 1.3°C and 1.6°C.

### PHOTON INDUCED PHOTOACOUSTIC STREAMING

Introduced by Mark Collona and Enrico De Vito after far-reaching research done at the University of Arizona 2010. Both the researchers had designed a specialized tapered and stripped radial emitting tip for Er: YAG laser where the last 4 mm of the outer sheath of the tip is stripped off. Laser parameters are 20 mJ (energy), 15 Hz (frequency), 0.3 W (power), 300 μm tip (diameter), 20-40 s (duration) tip of the laser is passively placed in to the pulp chamber inundated in sodium hypochlorite. Tip remains still in the chamber for the entire duration of 20-40 s which propagates lateral discharge of energy in a tight environment creating secondary cavitations. [12]

### REMOVAL OF BONE AND IMPLANTOLOGY

A low wattage is employed in the range of 1-2 W to remove bone with high water ratio to prevent unwanted heat build-up. Thin layer of cortical plate should be targeted, once that is done with much more easier to ablate the narrow spaces which expedites the procedure. Studies have shown that erbium irradiated bone displayed exaggerated fibroblast reaction and inflammatory cell infiltration, but surprisingly greater and more rapid neo bone formation was noticed. Irradiation continuously for 2 min did not yield any significant hike in the temperatures at implant bone interface. After erbium ablation smear layer free surfaces and well defined edges could be seen microscopically. Low output erbium energy could remove plaque and calculus on implant abutments without eroding titanium coatings and Er: YAG lasers were used to disinfect when used for perimplantitis, with a success rate of above 95%. [13]

### AUXILIARY APPLICATIONS

Dentigerous cyst

Benign odontogenic cysts commonly associated with an unerupted tooth in the mixed dentition as well as the permanent dentition. Accompanying complications are that once the cystic cavity expands the occlusion is deranged, displacement of adjacent teeth and pressure resorption in adjacent teeth. Erbium lasers can be engaged to vaporize the bony cavity and curettage of the cystic cavity, deduction of the cystic lining.

Herpes labialis

Complete dehydration of the herpetic lesion is achieved with minimum energy (approximately 25-30 mJ), initially at low frequency and gradually mounting to 25 Hz until the lesion takes on a white speckled appearance which reflects the absolute dehydration of the herpetic lesion. Focal spot of the laser tip held 1-2 cm away from the lesion without revisiting the areas already irradiated. Special care must be taken to prevent transfer of excess energy which might give an orange-brown appearance. Erbium therapy is absolutely asymptomatic and uneventful for the patient ultimately giving immediate and sustainable relief from the painful episodes associated with herpetic lesions.

### APRHOTOUS ULCER

It is quite different from other erbium applications, here the primary motive is to supply sublative energy without water to dry and detoxify the ulcer. Operator is able to initiate analgesic and biostimulating effects. Preferred power settings are 20 mJ, 20 Hz, 0.2 W, 20% air and no water spray. Almost immediately patients are relieved of the acute episodes associated with aphthae, advised to be careful in their choice of diet that is to avoid very spicy foods, avoid the site while brushing, benzocaine ointments and an analgesic in case of pain during the subsequent days. However the healing period is the same as that of conventional healing, laser therapy alleviates the painful episode and almost immediately a laser bandage is formed which promotes healing by secondary intention.

### GINGIVAL TUMORS

Vascularization in these lesions warrant the usage of mid-infrared laser especially Er, Cr: YSGG laser with the following parameters at power varying from 1.5 W to 2 W at 20 Hz repetition rates with air-water spray 20% and 15%.

Removal of residual root fragments

Erbium doped yttrium aluminum garnet lasers can be used without anesthesia, removing the inflamed gingival and thereby exposing the root fragment. Ideal parameters are 0.2 W, 30 mJ, 20 Hz, 30% air and no water supply. Healing is normally uneventful and asymptomatic.

Safety and certifications

Erbium lasers belong to Class IV category device that may cause injury through direct viewing or subjected to specular reflection. They may induce injury to the eye or skin due to their high power density. Use of safety glasses is obligatory. It is medical Class II B laser that must mandatorily bear the CE mark including a four-digit credentials figure of the notified body who performed compliance evaluation.

### CONCLUSION

Hard tissue lasers work very efficiently when the laser tip is held 1.5-2 mm away from the target tissue. If the optimum focal distance is not maintained optimal energy transfer may not materialize and result in non-optimal thermal relaxation time and fluences delivered to the tissue in question. The operator should be aware of the optimal energy, frequency and the ideal air-water ratio before commencing ablation. Magnification as an adjunct to laser therapy can be employed which will ensure better energy transfer and reduced wear of the erbium tips. Laser safety norms should be strictly followed as any stray radiation from erbium unit directly affects the cornea and the eye lens as both the tissues are rich in water content. Special filters are available which could be fit just below the beam splitters improves the safety standards. Overall this unique versatile tool has applications in almost all major areas of restorative dentistry and surgical procedures. Laser dentistry along with dental operating microscope and magnification enhance ergonomics, communication through integrated video and documentations.

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