A New Pioneering Advancement: Waterlase

Rinkee Mohanty[1], Bhagyashree Lenka[2], Rashmita Nayak[3], Anurag Satpathy[3], Abhaya C. Das[4], Gatha Mohanty[5]

[1]Professor & Head, [2]Postgraduate Trainee, [3]Professor, [4]Reader, [5]Senior Lecturer, Department of Periodontics & Oral Implantology, Institute of Dental Sciences, Siksha 'O' Anusandhan (Deemed to be University), Bhubaneswar, Odisha, India

Abstract

The Waterlase™ is a trailblazing tool for dentists which is an amalgamation of laser energy and water. This process is known as Hydro Photonics. This tool is proficient to perform many conventional dental procedures with less need for anesthesia. Hard and soft tissue can be cut using Waterlase without applying heat, vibration or pressure. The dental operator may easily carry out the procedure in the absence of anesthesia. Waterlase laser decreases post-operative bleeding, pain and swelling and the need for pain medication in many cases. It has been used for a variety of therapies such as hard and soft tissue procedures including caries removal, cavity preparation, endodontic therapy, designing and correcting smile, frenectomy, gingival excision, gingivoplasty, curettage, vestibular deepening, operculum excision, crown lengthening, flap surgery, and osseous surgical procedures,etc.

Keywords: *Waterlase, Lasers, Hard tissue therapy, Soft tissue periodontal surgery.*

Introduction

The diseases of the periodontium comprise of a group of inflammatory diseases. It is commenced by microbes that colonize the teeth and spread infection. Earlier, the local factors causing periodontal diseases were eliminated by the hand instruments and ultrasonic scaler.[1] However, calculus and plaque removal using traditional method has been considered to be insufficient and taxing.[2] For enhancing the usefulness and efficacy of debriding the root surface, different devices have been tried such scalers both ultrasonic and sonic. Recently lasers also have been used for the same.

Corresponding Author:
Prof. Rinkee Mohanty
Professor & Head, Department of Periodontics & Oral Implantology, Institute of Dental Sciences, Siksha 'O' Anusandhan (Deemed to be University), Bhubaneswar, Odisha, India
e-mail: rinkeemohanty@soa.ac.in

Laser: Laser is the **acronym** for **L**ight **A**mplification by **S**timulated **E**mission of **R**adiation. It generates electromagnetic wave. The heat released by the laser converts the electromagnetic energy into thermal energy. The laser follows the principle first given in 1917 by Albert Einstein. He proposed that light consists of mass-less particles called photons. The energy of the photons corresponds to the wave's frequency. As the frequency increases, the energy carried by the waves becomes greater. This is the principle of laser. Charles Townes and co-workers first demonstrated the action of laser in the microwave region for which he was later awarded the Nobel prize. A beam of ammonia molecules was passed through a system of focusing electrodes. Amplification occurred when a microwave was sent through the cavity at an appropriate frequency. This was termed microwave amplification by stimulated emission of radiation (M.A.S.E.R.). The term laser was first coined in 1957 by physicist Gordon Gould a physicist in 1957 who coined the term laser. The first Laser beam was generated in 1960 by Theodore H. Maiman at Hughes Research Laboratories. It is a solid-statelaser, that uses a pink ruby crystal. It is encompassed by a flash tube enclosed within a polished aluminum cylindrical cavity. It is cooled by forcing air through it.

Parts of laser:

Laser comprises the following constituents:

1. Laser medium- Can be in any state gaseous, liquid, or solid.An external energy source was passed through it.
2. Resonating chamber- It is a tube with two reflecting mirrors. One mirror is completely reflective, the other one partly transmitting light. Both are placed at either side of the optical cavity.

3. Power source- It pumps the atoms in the laser medium so that they can attain higher energy levels. It is either mechanical, optical or chemical source of energy.

Three factors are essential for the characteristics of the laser light:

1. Composition of the laser medium,
2. Energy source, and
3. Design of the resonating chamber.

Characteristics of laser: When an excited atom is stimulated to emit a photon spontaneously it results in the release of a subsequent photon. A monochromatic, collimated and coherent form of light is produced by the energized emission. This laser light on contacting the tissues gets reflected, scattered, absorbed ortransmitted to the surrounding tissues. The free water molecules, pigments, proteins and other macromolecules present in the oral cavity are the reason for photonic absorption in the mouth. This absorption causes an intracellular or intercellular change in the tissues. Shorter wavelengths of 500- 1000nm are readily absorbed in blood elements and chromophores. The Argon lasers are highly diminished by hemoglobin. The Diode lasers and Nd: YAG lasers have an increased affinity for melanin. Longer wavelengths interact more with H2O andhydroxyapatite molecules. The maximum absorption for H2O is just under 3000 nm for Er: YAG laser. At 10,600 nm CO2laser has the maximum affinity for hydroxyapatite and water.

Different wavelengths can be classified as:

1. The ultraviolet spectrum i.e. 100- 400 nm
2. The visible spectrum i.e. 400-700 nm
3. The infra-red spectrum i.e. 700 nm to the microwave spectrum

Depending on the wavelength Lasers can be of two types:

(i) Deep penetrating ones, such as Nd: YAG and diode. The laser light enters deep into the tissues and scatters.

(ii) Superficially absorbed ones, such as CO2, Er: YAG and Er, Cr: YSGG lasers. The laser light gets absorbed in the superficial layers. It does not penetrate or scatter deeply.

Various periodontal laser procedures: Laser has proved to be an effective device in the recent dental practices. It has not only increased efficiency, and specificity but has also enhanced the ease and comfort of carrying out dental treatment at minimal cost. A few of the uses and applications of specific lasers in different treatments are mentioned below.

Table 1. Uses and applications of specific lasers in different treatments

	Er:YAG 2940nm	Er,Cr:YSGG 2780nm	KTP 532nm	Argon 488 and 515nm	Diode 810-980nm	Nd:YAG 1064nm	Helium-neon 633nm	Diode 635, 670 or 830nm	CO_2 10600nm
Calculus removal	✔								
Periodontal pocket disinfection	✔	✔	✔	✔	✔	✔			
Photoactivated dye disinfection of pockets							✔	✔	
De-epithelialization to assist regeneration	✔	✔							✔

Effect of lasers on bacteria and calculus: Most laser bactericidal studies reported that when the density of the energy is enhanced results in decreased bacterial load. Cobb CM et al 1992 reported that a decrease in period onto pathogens followed by the use of Nd: YAG laser shows reduction in *P.gingivalis, P. intermedia and A. actinomycetemcomitans*. However, recolonization of multiple morphotypes of bacteria was observed postoperatively in laser-treated subgingival root surfaces Moritz et al (1997) proposed that Er: YSGG laser in

adjunct to SRP enhanced healing of periodontal pockets. Aoki et al (2000) suggested that Er: YSGG laser has the proficiency to remove calculus which is at par with ultrasonic scaling.[3-5]

Latest Developments:

Periowave™: Periowave™: It is a system that is based on the principle of photodynamic disinfection. It uses non-toxic dye (photosensitizer) along with a low-intensity laser. This enables singlet oxygen molecules to eliminatemicrobes. Each site requires only one minute of laser activation, making it a swift and painless treatment(6).

Waterlase: Er, Cr: YSGG (Erbium-Chromium doped: Yttrium-Selenium Gallium-Garnet) laser is available commercially as Periodontal Waterlase MD™ and The Waterlase® C100 It utilizes a patented amalgamation of laser energy and water to perform various dental procedures. It is so precise that the dentist can restore the teeth, gums, and bones without damaging the surrounding structures.

What is Waterlase dentistry?: This dentistry is an alternative to conventional treatments. It works in the absence of heat, vibration, and drilling. Hence providing a minimally invasive, precise approach.

It uses advanced technology to:

- Alleviate patient's anxiety
- Carry out minimally-invasive procedures
- Significantly reduce the need for retreatment
- Comfortably prepare patients for invasive treatments
- Perform treatment without anesthesia
- Reduce post-treatment bleeding and swelling, and pain
- Provide effective treatment in minimal time

The handpiece resembles a high-speed handpiece but it has fiber optic tips instead of bur. This directs the laser energy at a focal point about 1 to 2 mm from the tissue surface. It weighs 88 pounds, and has dimensions of 12.5×26×32 inch. It needs about 80 pounds per square inch of air pressure provided by an external source. The water supply is placed in an attached bottle.[7] Hydrokinetic energy is generated by combining a spray of atomized water with laser energy. The resulting Hydrokinetic energy smoothly and precisely cuts hard and soft tissue such as tooth enamel and soft tissue.

Advantages of Waterlase:

- Itremoves hard and soft tissue without any discomfort
- It requires less anesthesia
- It decreases post-operative pain, bleeding and swelling,
- Waterlase precisely cuts the tissues leaving the surrounding areas unaffected minimizing trauma
- Treatments can be simultaneously performed in several areas of the mouth, resulting in a decreased need for multiple visits.

Hard tissue procedures: The YSGG laser generates optical energy to a user-controlled distribution of atomized water droplets. The hydrokinetic cutting effect occurs due to the absorption of the optical energy by the water droplets. The removal of tissues with highly energized water particles is the principle behind the hydrokinetic process. Enhanced absorption of laser energy by atomized water droplets results in an intense yet controlled water particle excitation and micro-expansion. The water vapor released causes an increase in the internal pressure within the tissue, resulting in an explosive expansion called 'micro explosion'. These results in 'thermomechanical' or 'photomechanical' ablationby mechanical collapsing the tissue. This process is termed as 'water-mediated explosive ablation'. Various studies have reported that Er, Cr: YSGG laser can be comfortably used on osseous tissue bone without anycharring or melting. No physical contact is made with the hard tissue while cutting it; i.e. the laser energy is transmitted to the water, which is further transmitted to the tooth leading to tissue ablation.[8,9]

Soft Tissue Procedures: These procedures are done using a different mode where direct Er, Cr: YSGG laser energy is applied to cut or ablate the soft tissues. Adequate anesthesia is needed to perform soft tissue procedures. The water is need for cooling, keeping the tissue moist and clean and for hydrating. Waterlase laser energy is delivered via a flexible fiber-optic device. The laser does the cutting while the water released acts as a coolant. For soft tissue procedures, the Waterlase® C100 utilizes direct laser energy to cut tissues, incise, excise, ablate and coagulate.

Two key features are:

1. Reduces bleeding in the operative field
2. Decreased post-operative pain and discomfort in comparison to traditional procedures.

The power source, the pulse energy, rate of repetition and rate of flow of air and water are adjustable in all the applications according to user requirements.

Uses in Periodontics:

1. Root planing procedures
2. While giving incisions in cases of Full-thickness/ Partial-thickness flap
3. In cases of curettage
4. Granulation tissue removal from the osseous defects
5. During debridement
6. While recontouring bone to restore its architecture
7. Respective osseous crown lengthening
8. Soft tissue procedures such as removal of the gingivaand frenum
9. Implant recovery
10. Painless excision of epulis caused by faulty dentures
11. Low-level laser therapy is used for early detection of caries
12. Lasers are used for providing restorative therapy having longer and better prognosis due to its microbial actions in caries removal procedure.
13. Dental lasers are also used as sealantsfor dentinal tubules that are the primary reason for dentinal hypersensitivity.

Waterlase with Emdogain™, is a regenerative gingival therapy. This device promotes the regeneration of soft and hard tissue that has been degraded due to chronic periodontitisand observed the combination of the two procedures for over nine years. He also concluded that this method of treatment has immense potential in the healing of the periodontal treated sites.

Drawbacks, Cautions and Contraindications:

1. The Er: YSGG laser has few drawbacks when used subgingivally.
2. While applying laser in the periodontal pockets, the visibility of the operator is compromised. Hence special tip designs should be facilitated for better insertion into the pockets. This can also aid in the detection of the subgingival calculus.
3. High-speed evacuation is necessary to pump out the water released during the explosive ablation causing splatter of blood and water from the pockets. This can be carried out by not only using an intraoral suction but also an extraoral evacuator. Thus cross-contamination can be prevented by the splashes of blood and water.
4. In cases of systemic health conditions extra caution and precaution should be exercised. In cases allergy to anesthesia, cardiac disorders, respiratory problem and blood disorders use of lasers can be contra indicated local procedure. Immuno-deficiency may also pose as a contraindication. Hence medical consent from the patient's physician is mandatory in the above-proposed cases or doubt.

Precautions:

1. Inadequate knowledge about the usage of controls or adjustments or performance of procedures may lead to harmful radiation exposure.
2. This device has been designed to meet the requirements of excessive electromagnetic, electrostatic and radio frequency interference testing. However, there remains the possibility of other interference persisting.
3. One should never carry out any procedure if he/she thinks that the device is not functioning properly.

Directions for safety:

These instructions should be strictly followed at all times:

- Highly reflective items in the vicinity of the operating field should be removed or covered.
- No explosive or flammable things should be present nearby.
- Protective eyewear must be worn by the operator and personnel surrounding the operative field suitable to block 2.78 μm wavelengths.
- One must make sure that Waterlase® C100 Handpiece Mirror is clean. There should be an absence of water or moisture.

Do not directly look into the beam or at specular reflection.

- The cutting spray should be directed towards the target tissues and not elsewhere.
- STANDBY button on the control panel must be pressed before switching off the unit.
- Before exchanging handpieces or removing the fiber optic connector from the unit press STANDBY.

Move the circuit breaker to the OFF (O) position (located on the rear panel) and remove the key before leaving the unit unattended.

Future developments: There is a great potential for laser systems to be developed further to include additional features and functions. The Alexandrite laser is a solid-state laser, which could remove dental calculus selectively. Mechanism of selective ablation has not been clarified yet. The development of this laser for clinical use is widely expected due to its excellent ability for selective calculus removal from the tooth structure. Solid-state lasers are being designed that have higher power, are faster, have shorter wavelengths, and better beam quality, which will expand their applications.

Conclusion

Er, Cr: YSGG laser effectively performs numerous soft tissue procedures with little or no bleeding and gives the dentist a new high-tech tool for many procedures that previously required referral to a specialist. Now one can have them performed during the scheduled appointment. Through this new innovative technology that seems to be extremely effective, there is a great need to develop an evidence-based approach to the use of Waterlase in periodontics. More controlled studies are needed to establish its usefulness in the field.

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