New Innovative Technology: Waterlase in Periodontics

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Abstract:

The Waterlase ™ is a revolutionary tool for dentists which is a unique combination of laser energy and water, a process called Hydro Photonics™, to perform many traditional dental procedures with less need of anesthesia. Since the Waterlase laser cuts hard and soft tissue without heat, vibration or pressure, the dentist may be able to perform the procedure without anesthesia. Also, using the Waterlase laser reduces bleeding, post-operative pain and swelling and the need for pain medication in many cases. It is extremely versatile. It can be used for a wide range of hard and soft tissue procedures including decay removal, cavity preparation, root canals, smile design, frenectomy, gingivectomy, gingivoplasty, curettage, vestibuloplasty, operculectomy, crown lengthening, flap surgery, removal of granulation tissue and bone surgical procedures and many others.

Key Words: Waterlase, Hydrophotonics, Hydrokinetic energy, Er. Cr: YSGG Laser, Photothermal.

Introduction:

Periodontal disease consists of a group of inflammatory diseases initiated by bacteria that colonize the teeth and infect their surrounding soft tissues. The end result of this infection is the clinical manifestation of disease which results in several distinct signs and symptoms. In the past, scaling and root planing comprising both hand instruments and ultrasonic seals have played a pivotal role in the elimination of causative factors of periodontal disease throughout periodontal therapy (Shigeru et al, 2004). However, removal of calculus using conventional and hand instruments has been reported to be incomplete and time consuming (Yukna et al, 1997). In order to improve the effectiveness and efficacy of root surface debridement, various devices such as sonic and ultrasonic scalers, and more recently lasers have been used (Lee, 2007).

The use of lasers for treatment has become a common phenomenon in the medical field. The first laser device was made by Maiman (1960), based on theories derived by Einstein in the early 1900s. The application of a laser to dental tissue was reported by Stern & Sognnaes (1964). Goldman et al (1964) described the effects of ruby laser on enamel and dentine with a disappointing result. The lasers available in dentistry are mainly Ruby, Nd:YAG, Co₂, Ho:YAG, Er:YAG, Er,Cr:YSGG, Nd:YAP, Argon, Diode. Until now, lasers were mainly applied to soft tissue procedures. Recently, Erbium doped: Yittrium-Aluminium-Garnet (Er: YAG) and Erbium-Chromium doped: Yttrium-Selenium-Gallium-Garnet (Er, Cr: YSGG) laser scaling was introduced as an alternative or an adjunctive to conventional scaling and root debridement.

Er: YAG and Er, Cr: YSGG laser comprises of a fiber optic bundle from which wavelength is emitted in a free-running pulsed mode. At the end of delivery system, a hand-piece & small- diameter glass tip is present to concentrate the laser energy to a set of approximately 0.5 µm. Additional air and water spray are provided for dental procedures (Eversole & Rizoni, 1995).

Meyer et al reintroduced use of Laser in dentistry in the year 1984. While lasers have been involved in dentistry for more than 20 years, until recently, no single laser had been cleared for all oral tissues, including hard and soft tissue. The newly developed Waterlase™ performs scaling and root planing along with the disinfection of the gingival sulcus. Waterlase technology involves the spray of atomized water with laser energy, known as Hydrokinetic energy and helps to perform dental procedures in fewer appointments with less need for anesthesia, scalpels and drills (Cobb, 2006).

What is Waterlase?:

Erbium-Chromium doped: Yittrium-Selenium-Gallium-Garnet (Er, Cr: YSGG) laser is commercially available as Waterlase (Fig. I). It uses a patented...
combination of laser energy and water by a process called Hydro photonics, to perform a wide range of dental procedures. The Hydrokinetic process is the removal of tissues with YSGG laser-energized water droplets. Hydrokinetic energy is produced by combining a spray of atomized water with laser energy. The resulting Hydrokinetic energy gently and precisely removes a wide range of human tissue including tooth enamel and soft tissue with no heat and no pain in most cases. Laser-powered hydrokinetic system (LPHKS) uses an Er, Cr: YSGG crystal with a photon emission wavelength of 2.78 micrometers (Hadley et al, 2000). The absorption coefficient for water is 0.00029 for argon laser, 0.020 for diode laser, 0.61 for Nd: YAG laser, 12,000 for Er: YAG laser and 860 for CO_{2} laser. The absorption coefficient of water of the Er: YAG laser is theoretically 10,000 which is 15,000-20,000 times higher than that of the CO_{2} and Nd: YAG lasers, respectively. The laser hand piece (Fig. II) resembles a high-speed hand piece but with fiber optic tips instead of bur, which directs the laser energy at a focal point approximately 1 to 2 mm from tissue surface. Weighing 88 pounds, waterlase has dimensions of 12.5×26×32 inch. It requires about 80 pounds per square inch of air pressure provided by an external air source. The water supply is located in an attached bottle that is easily removed for water replacement (Nash & Colonna, 2002).

The proposed mechanism of Laser-powered hydrokinetic system (LPHKS) is that the Er, Cr: YSGG-pulsed laser source delivers photons into an air-water spray matrix with resultant micro explosive forces on water droplets. The laser energy couples the hydroxyl radical in the apatite crystal and the water that is bound to the crystalline structures of the tooth. The vaporization of the water within the mineral substrate causes a maximum volume expansion that causes the surrounding material to explode away (Hossain et al, 1997). The LPHKS with its accompanying air water spray has been shown to cut enamel, dentin, cementum and bone efficiently and cleanly without deleterious thermal effects on dental pulp. Scanning electron microscopy has shown that LPHKS makes clean cut through enamel and dentin without creating smear layer (Hadley et al, 2000). A mechanism of action of biological tissue ablation with waterlase has been proposed, based on the optical properties of its emission wavelength and morphological features of the surface ablated by the waterlase. During the waterlase irradiation, the waterlase energy is absorbed selectively by water molecules and hydrous organic components of biologicalal tissues, causing evaporation of water and organic components and resulting in thermal effects due to the heat generated by this process (photothermal evaporation). Moreover, in hard tissue procedures, the water vapor production induces an increase of internal pressure within the tissue, resulting in explosive expansion called ‘microexplosion’. These dynamic effects cause mechanical tissue collapse, resulting in ‘thermomechanical’ or ‘photomechanical’ ablation. This phenomenon has also been referred to as ‘water mediated explosive ablation’.
For hard tissue procedures, working on teeth the work is actually done by a laser energized through a “hydrokinetic” process. It has been indicated by various studies that Er, Cr: YSGG laser is a suitable procedure for use on bone without any evidence of charring or melting (Cobb, 2006). When cutting hard tissue, no physical contact is made with the tissue. That is, the laser energy is transferred to the water, which is then transferred to the tooth vaporizing the tissue. For hard tissue applications spray is part of tissue removal process as well as hydration, cooling and keeping the tissue clean.

Soft tissue procedures are performed using a different mode of operation where direct Er, Cr: YSGG laser energy is applied to incise, excise or ablate these tissues. For laser application to the soft tissues, adequate anesthesia of that area is required. In soft tissue procedures the water is applied for hydration, cooling or to keep tissue clean. A flexible fiber-optic device delivers the waterlase laser energy. For the soft tissue procedures the laser itself does the cutting with the water stream acting as a coolant. A visible light emitted from hand piece distal end pinpoints the area of treatment. In both hard and soft tissue applications the power output, the pulse energy, repetition rate and air and water flow rates are adjustable to specific user requirements.


With respect to healing after Er: YSGG scaling, no histologic studies have been reported after periodontal treatment using the Er: YAG laser, min thermal changes have been reported after Er: YSGG irradiation on both hard and soft tissue. Therefore, further studies are necessary to clarify the histologic attachment of periodontal tissues to the irradiated root surface in vivo.

The Waterlase laser was first cleared by the Food & Drug Administration (FDA) to cut tooth structure in 1998.

Uses in General Dentistry:
A. Hard tissue indications
   • Tooth preparation to obtain access to root canals
   • Biomechanical preparation of root canals
   • Laser root canal disinfection after endodontic treatment
   • Cutting of bone to prepare a window access to the apex of the root.
   • Apicoectomy - amputation of the root end.
   • Root end preparation for retro fill amalgam or composite.
   • Cutting, shaving, contouring and resection of oral osseous tissues (FDA clearance 1998).

B. Soft tissue indications including pulpal tissues
   • Excisional and incisional biopsies
   • Implant recovery
   • Incision and drainage of abscess
   • Pulp extirpation

Advantages of Er, Cr: YSGG Laser (Waterlase):
1. The Waterlase laser cuts hard and soft tissue with out heat, vibration or pressure and procedures are performed with less anesthesia. It also, reduces bleeding, post-operative pain and swelling, and the need for pain medication in many cases.
2. Waterlase is used for removal of decay in tooth while leaving the surrounding tooth structure unaffected.
3. The gentle action of the Waterlase laser reduces damage to healthy portions of the tooth, minimizing trauma.
4. Since the need for anesthesia is reduced; cavity preparation can be simultaneously performed in several areas of the mouth, rather than the need for multiple visits.

Uses in Periodontics:
1. Incisions for Full thickness/ Partial thickness flap
2. Laser soft tissue curettage
3. Removal of granulation tissue from bony defects
4. Sulcular debridement
5. Ostectomy (resection of bone to restore bony architecture, resection of bone for grafting, etc.)
6. Osteoplasty and osseous recontouring
7. Osseous crown lengthening
8. Soft tissue procedures such as gingivectomy, gingivoplasty, depigmentation, frenectomy.

Drawbacks, Cautions and Contraindications:
As the Waterlase is quite expensive, it may not make it into many smaller dental practices. All clinical procedures performed with the Waterlase™
must be subjected to the same clinical judgment and care as with traditional techniques. Patient risk must always be considered and fully understood before clinical treatment.

The clinician must completely understand the patient’s medical history prior to treatment. The Er: YSGG laser has some shortcomings when used for subgingival scaling. For clinical application in periodontal pockets where the operator cannot visualize the irradiated target, special tips should be designed to facilitate insertion into the periodontal pocket and detection of the presence of dental calculus on the surface. Also, since Er: YSGG laser irradiation causes splashing of water and blood from pockets as a result of explosive ablation, adequate high speed evacuation by means of not only an intraoral suction but also an extraoral evacuation apparatus is required to prevent contamination by blood and water splattering.

Exercise caution for general medical conditions, which might contraindicate a local procedure. Such conditions may include, but are not limited to, allergy to local or topical anesthetics, heart disease, lung disease, bleeding disorders, sleep apnea or an immune system deficiency. Medical clearance from the patient’s physician is advisable when doubt exists regarding treatment.

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. Though this new innovative technology 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.

Bibliography: