From everyday dentistry to advanced photoacoustic endodontic applications (PIPS): Er:YAG & Nd:YAG dual wavelength laser

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Introduction

Lasers provide an exciting new technology that allows the dentist the ability to give patients optimal care without many of the fears factors found in conventional dental techniques. Used with proper understanding of laser physics, lasers are extremely safe and effective. Using lasers for caries removal, postoperative discomfort and infection, and for soft and hard tissue procedures can reduce postoperative discomfort and infection, and provide safe, simple, and painless treatment. As a result, we can improve our efficiency, expand what we can do, achieve better results and increase production. Lasers represent a fundamental change in the entire way dentistry has been taught. We can now rethink and often replace ultrasonic and chemical irrigation, in an attempt to shape, clean, and decontaminate the endodontic system. Clinically, traditional endodontic treatment is open to many concerns by many, although not all. They question the use of antibiotics and X-rays and their possible side effects about the need to take radiographs because of the nature of the medium infrared laser. Lasers may be used for endodontic treatment, but still fall short of successfully removing all of the infective microorganisms and debris. This is because of the complex root canal anatomy and the inability for common irrigants to penetrate into the lateral canals and the apical ramifications. It seems, therefore, appropriate to look for new materials, technologies and techniques that can improve the cleaning and the decontamination of these anatomical areas.

Among the new technologies, the laser has been studied in endodontics since the early 1970s and has become more widely used since the 1990s. Different wavelengths have been shown to be effective in significantly reducing the bacteria in the infected canals, and important studies have confirmed these results in vitro. Studies reported that near infrared lasers are highly efficient in disinfecting the root canal surfaces and the dentinal walls (up to 750 microns for the diode 810 nm and up to 1 mm for the Nd:YAG 1064 nm). On the other hand, these wavelengths did not show effective results in debridging and cleaning the root canal surfaces and caused characteristic morphological alterations of the dentinal wall. The smear layer was only partially removed and the dentinal tubules primarily closed as a result of use of the inorganic dentin structural treatments.1

The erbium laser can be used for repairing incipient hard tissue disease allows the dentist to provide a stress-free means of restoring teeth in a minimally invasive manner, most often with no shot and no numb lip, without the need for any local anesthetics. The erbium laser can be used for restoring primary and permanent teeth, eliminating or reducing the amount of local anesthetics. In most cases, the patient will not require numbing for Class I, 2 (sometimes), 5, 4, 3, 6, 7, 8, 9, 10 restorative procedures using bonded restorative materials. Using the concept of minimally invasive restorative procedures, the Er:YAG laser allows the operator to remove only diseased tissue and thus preserves much of the healthy, unaffected tooth. In cases where alloy is preferred, the laser’s angulation effect may also allow the dentist to create a restoration preparation using the erbium laser which provides ample evidence that this method is both effective and safe for children who may be needed for introducing chemicals or using electrosurgery methods. When the final result of orthodontic positioning of the front teeth results in gingival hyper trophy, the laser can be a useful tool to increase crown length and give the patient a more esthetic smile. This may often be accomplished without the need for local anesthesia. Patients who have medically induced hyperplastic tissue, such as patients requiring diastin, can also have their tissue reduced and reshaped with the erbium.

In addition to the many examples described in this article, lasers can be used for additional procedures not usually required in pediatric dentistry, such as revisions of the abnormal mandibular frenum, often avoiding the need for soft-tissue grafts, crown-lengthening procedures where bone has not recontoured, apicectomies, removal of bony exostoses, removal of third molar impactions, removal of root remnants, incising and draining soft-tissue infections, advanced periodontal treatments and the latest in advanced endodontic treatment via photodirected photoacoustic stream.

Photoacoustic endodontic using PIPS

The goal of endodontic treatment is to obtain effective cleaning and decontamination of the smear layer, bacteria and their byproducts in the root canal system. Clinically, traditional endodontic techniques use mechanical instruments, as well as ultrasonic and chemical irrigation, in an attempt to shape, clean and completely decontaminate the endodontic system but still fail short of successfully Fig. 1, 2. Representative sample images of root canal dentinal walls irrigated with 17 percent EDTA and PIPS for 20 seconds. (Photos/Provided by Technology4Medicine)

3. Other studies reported the ability of the medium infrared laser in debridging and cleaning root canal walls.5, 6 The bacterial load reduction after erbium laser irradiation demonstrated high on the dentin surfaces but low in depth of penetration because of the high absorption of laser energy on the dentin surface.7 Also the laser activation of commonly mCME articles in Dental Tribune have been approved by:

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used irrigants (LAI) resulted in statistically more effective removal of debris and smear layer in root canals compared with traditional techniques (Cl) and ultrasonic (PU).1,14 Additionally, the laser activation method resulted in a strong modulation in reaction rate of NaOCl, significantly increasing production and consumption of available chlorine in comparison to ultrasonic activation.15

A recent study has reported how the use of an Er:YAG laser, equipped with a newly designed nanofiber and stripped, in combination with 17 percent EDTA solution, using very low pulse duration (50 microseconds) and low energy (20 mJ) resulted in effective debris and smear layer removal with minimal or no thermal damage to the organic dentinal structure through a photoacoustic technique called photo induced acoustic streaming or “PIPS.”12,13 Also the use of the PIPS protocol in combination with 5.25 percent sodium hypochlorite solution has been investigated and shown to reduce the bacterial load and its associated biofilm in the root canal system three dimensionally.12,13

Other similar studies are in progress for publication and the results are promising and suggest a great potential for this new concept of effective of this laser activated decontamination (LAD) method. The purpose of this article is to present briefly the experimental background of this laser technique and introduce the clinical protocol.

Scientific background

The microphotographic recording of the LAD studies suggested that the erbium lasers used in irrigant filled root canals generate a streaming of fluids at high speed and in a strong shock wave.13 The thermal effect is generated by the water molecules, creating a typical shock wave and a strong “shock wave” that leads to the formation of an effective streaming of fluids inside the canal wall also interacting with the smear layer debris. The thermomechanical effect from the laser activation process is related to the risk of apical perforation, leading and surface thermal damage, because of the ablation ability of this wavelength. Also a combination of the near and medium infrared lasers has been proposed for root canal disinfection, called twirlight endodontic treatment (TET), uses the erbium laser energy to improve the cleaning and disinfecting action of the sodium hypochlorite.12 The disinfecting action of PIPS is very effective both on the root surface, the lateral canals and the dentinal tubules, as confirmed by SEM and confocal studies (Fig. 4).

The profound and distant effect of PIPS eliminates the need to introduce the tip into the root canal system. Unlike traditional laser techniques requiring placement of the tip 1 mm from the orifice, even 5 mm from the apical foramen and safety, lasers provide our practice and can be used in many instances instead of the conventional methods employed by the vast majority of dentists. Incorporating a laser in the dental practice should be viewed as an investment rather than a cost. When used with a good knowledge of laser physics, training and safety, lasers provide our patients a new standard of dental care.

References


2. CAPPmea together with Dental Tribune provides the opportunity for the upper echelon of dental medicine, but also presents a regional standard proficiency course provider for the Middle Eastern and African region.


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