Lasers provide an exciting new technology that allows the dentist the ability to give patients optimal care without many of the “four factors” found in conventional dental techniques. Used with proper understanding of laser physics, lasers are extremely safe and effective. Using lasers for caries removal, periodontal treatment, endodontic treatment, bone management, cutting and shaping, and soft-tissue procedures can reduce postoperative discomfort and infection, and provide safe, simple in-office treatment. As a result, we can improve our efficiency, expand what we can do, achieve better results and increase production.

Lasers represent a real quantum leap forward in the treatment of our patients, including the pediatric patient. The U.S. Food and Drug Administration (FDA) gave approval for the use of the Er:YAG laser in 1997 for both hard- and soft-tissue procedures. The erbium laser (placed within the YAG crystal) of Yttrium-Aluminum-Garnet’s (Er:YAG) development and success made the treatment of children safer and quicker.

Plainly stated, a laser is a piece of equipment that creates a concentrated monochromatic beam of visible or infrared light that can be absorbed by a specific target. Since then, laser-assisted dental care has changed forever the way dentists can prepare diseased teeth, ablate bone and treat soft-tissue abnormalities and disease.

An entire new standard of care is being established.

Lasers and pediatric dentistry are a perfect fit. There are a wide range of hard and soft dental procedures that may be completed using lasers as an alternative to conventional dental care on adults and, especially, children. Many conventional procedures may be treatments dentists historically refer to other specialists; however, if you understand and use your laser efficiently, you will discover that many of these procedures that every dentist can easily complete.

The question is that often the major concern and barrier to implementing lasers is how this is incorporated into your practice. In the recently described as return on investment (ROI). Will it pay for itself? We prefer to speak of this as the secondary effect. If you understand your laser, it will easily pay premium on your investment, and the cost factor becomes a non-issue.

The purchasing of lasers is an investment, not an expense, for any dental practice.

Lasers represent a fundamental change in the entire way dentistry has been taught. We can now rethink and modify G.V. Black’s principle of extension for treatment.

The use of the new generation Er:YAG laser is effective because of its effect on its primary tissue target water. It is its primary tissue target because water is its primary tissue target. The erbium laser can be a useful tool to increase crown length and give the patient a more esthetic smile. This may be accomplished with the use of local anesthesia.

Patients who have medically induced hyperplastic tissue, such as patients requiring dilantin, 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 requires recontouring, apicectomies, removal of bony exostoses, recontouring, apicoectomies, and debris. This is because of the chemical makeup of the laser radiation demonstrated high on the tissue because of drugs or poor hygiene, laser can be a useful tool in increasing crown length and give the patient a more esthetic smile. This may be accomplished with the use of local anesthesia.

Parents often express concern about the need to take radiographs because of the risk of X-rays and their possible side-effects on a child’s overall health. They question the use of alloys because of the chemical makeup of the alloy. Whether these should be a real concern in today’s dentistry is open to debate, depending on your individual beliefs. There are also concerns by many, although not as loudly, about the effect of various pulpotomy procedures used in pulpotomy procedures, such as for necroresol.

Lasers provide a safe, non-invasive, effective and alternative treatment for pulpotomies. During the span of eight years, post-treatment results on more than 4,000 pulpotomies using the erbium laser provide ample evidence that this method is both effective and safe for children without the need for introducing chemicals or using electrosurgery.

When the final result of orthodontic positioning of the front teeth results in gingival hypertrophy, the laser can be a useful tool to increase crown length and give the patient a more esthetic smile. This may be accomplished with the use of local anesthesia.

Among the new technologies, the laser has been studied in endodontics since the early 1970s and has become more widely used since the 1980s. 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 laser are highly efficient in disinfecting the root canal surfaces and the dental walls (up to 75 minutes for the diode laser) and up to 4 mm for the Nd:YAG laser). On the other hand, these wavelengths did not show effective results in debridging and cleansing the root canal surfaces and caused characteristics morphological alterations of the dentinal wall. The smearlayer was only partially removed and the dentinal tubules primarily closed as a result of melting of the inorganic dentinal structures.

Other studies reported the ability of the medium infrared laser in debridging and cleaning root canal walls. 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. Also the laser activation of commonly used irrigation protocols results in statistically more effective removal of debris and smear layer in root canals compared with traditional techniques (U) and ultrasound (P). Alternatively, 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 ultrasound activation.13 A recent study has reported how the use of an Er:YAG laser, equipped with a newly designed radial and stripped tip, in combination with 17 percent EDTA solution, using very low power fluence duration (50 microradians) 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 photon induced photoacoustic streaming or “PIPS.”14,15 Also the same photoacoustic protocol in combination with 3.25 percent sodium hypochlorite has been investigated and shown to reduce the bacterial load and its associated contamination of the endodontic system through a three-dimensional positive effect.16 Other similar studies are in progress for publication and the results are promising and suggest a three-dimensional positive effect of this laseractivated decontamination (LAD) method.

Scientific background

The microphotographic recording of the lateral canals and the dentinal walls irrigated with 17 percent EDTA and laser activated for 20 seconds showed 400 microns tip (Fotona Light Diode laser, Latvia) and the erbium lasers used in irrigant-filled root canals generate a streaming of fluids at high speed through a cavitation effect.17 The laser thermal effect generates the expansion of the irrigation fluid molecules of the irrigation solution, generating a secondary cavitation effect on the intracanal fluids. To accomplish this streaming, it is suggested the fiber be placed in the middle-third of the canal, 5 mm from the apex and stationary.18 This concept greatly simplifies the laser technique, without the need to reach the apex and to negotiate radicular curves.

Also, the recorded video of the new technique, PIPS, showed a strong agitation of the liquids inside the canals. It differs from the already cited LAD technique by activating the irrigation solutions in the root canals through a profound photoacoustic and photochemical phenomena. The use of low energy (50 microsecond pulse, 20 mJ at 15 Hz, 0.5 W average power, or less) generates only a minimal thermal effect. The study with thermoocuples applied to the radicular apical third revealed only 1.2 degrees C of thermal rise after 20 seconds and 1.5 degrees C after 40 seconds of continuous radiation.19

When the erbium laser energy is delivered at only 50 microsecond pulse duration through a special designed tapered and stripped 400 microns tip (Fotona Light Diode laser, Technology4Medicine), it produces a large peak power of 400 watts when compared to a longer pulse duration. Each impulse, absorbed by the water molecules, creates a strong water wave that leads to the formation of an effective streaming of fluids inside the canal while also limiting the undesirable thermal effects seen with other methodologies. The placement of the tip in the apical portion only of the treated tooth allows for a more minimally enlarged canal preparation with less thermal damage as seen with those techniques placed into the canal system.

The root canal surfaces irrigated with 17 percent EDTA and laser activated for 20 seconds showed exposed collagen matrix, opened tubules and the absence of smear layer and debris (Figs. 1-5). The running with 5.25 percent sodium hypochlorite and laser irradiation for 20 seconds produced a strong activation of the solution, as reported by MacCune,20 improving the disinfecting action of the sodium hypochlorite.21 The disinfecting action of PIPS is very effective both on the root surface, the lateral canals and the dentinal tubules, as confirmed with 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 apex, or even 5 mm from the apex as proposed for LAI, the PIPS tip is placed in the middle-third of the pulp chamber only and left stationary, allowing the photoacoustic effect to spread into the endodontic system. A new tip design consisting of a 400-micron diameter, 12 mm long, tapered end is used for this technique (Fig. 5). The final 5 mm of coating is stripped from the end to allow for greater lateral emission of energy compared to the front tip. This mode of energy emission allows for improved lateral diffusion with low energy and enhanced photoacoustic effect.

Discussion

Laser irradiation is a common technique used in endodontics to improve the cleaning, the debridging and disinfection of the root canal system. Many wavelengths and protocols are used. Near infrared lasers are used for the three-dimensional decontamination of the root canal system. Nd:YAG and diode lasers use thermal energy to destroy bacteria. Observations reveal a great certainty of grade of thermal injury to the root canal surface and create a typical morphological damage. Moreover, they are not able to thoroughly remove the smear layer.

On the contrary, erbium lasers are used for their effective smear layer removal while their bactericidal activity is limited to the root surface. The plating of the tip close to the apex and its back movement during the activation process is related to the risk of apical perforation, lodging and surface thermal damage, because of the ablation ability of this wave-length. Also a combination of the near and medium infrared lasers has been proposed. A technique, called twinning endodontic treatment (TET), uses the erbium laser energy first, to clean the root canal surface and remove the smear layer, and the Neodimium:YAG laser second, used in dry mode as the final disinfecting step. All these techniques utilize traditional tips and fibers placed into the canal, close to the apex (1 mm) with all the corresponding thermal disadvantages observed in long, narrow and curve canals. The erbium lasers are also used as a medium of activation of commonly used irrigants (LAI), avoiding the risk of thermal damage, while increasing the cleaning and disinfecting activity of the fluids. PIPS, in particular, reduces all these risks and disadvantages, thanks to the position of the tip in the coronal orifice only and to the use of minimally ablative energy levels of 20 mJ or less.

The findings of our studies demonstrated that PIPS technique resulted in a safe and effective debridging and decontaminating of the root canal system. Our clinical trials showed that PIPS technique greatly simplifies root canal therapy while facilitating the search for the apical terminus, debridging and maintaining patency.

As a result of the efficacy of PIPS, the final size required for canal shaping can be significantly reduced, often to a size 25/04, allowing for a more minimally invasive and biocompatible treatment that can then be obturated three dimensionally.

Conclusion

Lasers are an extremely versatile addition to the dental 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 us a new standard of dental care.

References


Full list of references is available from the publisher.

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