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Laser Assisted Endodontic Irrigation: A Review

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Abstract

Effective root canal system disinfection and reinfection avoidance are the cornerstones of successful root canal therapy. These objectives are not always reached by current chemomechanical cleaning techniques, and inadequate root canal disinfection is the primary cause of endodontic failure. The use of laser treatment to clean and disinfect the root canal system has been suggested due to the high energy level and unique properties of laser light. The objective of the present review of literature is to discuss the role of laser assisted irrigation in endodontics.

Keywords: *Endodontics, Irrigation, Disinfection, Laser*

Introduction

Effective root canal system disinfection and reinfection prevention are essential for the success of root canal therapy for teeth with periapical infection. [1-3] In the past, it was done using a combination of mechanical equipment and irrigation with disinfectant solutions. Instrumentation does not guarantee a bacteria-free root canal, even though it can decrease bacterial load by mechanically removing microbes and infected dentine tissue.[4] Therefore, a lot has been anticipated from different disinfecting solution combos. For root canal irrigation, sodium hypochlorite (NaOCl) at 0.5 to 5.25% is still regarded as the gold standard owing to its broad antimicrobial spectrum of action and capacity to dissolve organic tissue.[5,6] Other antimicrobial irrigants have been researched but have not yet been shown to be more successful than NaOCl. These include chlorhexidine, potassium iodine, MTAD (a combination of tetracycline, citric acid, and a detergent), and QMix (a combination of ethylenediaminotetraacetic acid, chlorhexidine, and detergent).[7]

Although syringe irrigation is a commonly used technique, it is sadly ineffective in the apical portion of the root canal.[8] A potent technique for irrigation of root canals has been introduced: laser-activated irrigation (LAI). Through a powerful absorption of laser energy, laser irradiation causes brief cavitation in the liquid.[9] The objective of present review of literature is to discuss the role of laser assisted irrigation in endodontics.

Laser Assisted Irrigation: The use of a laser to irradiate commonly used irrigant solutions in the canal is known as laser-activated irrigation (LAI). Erbium laser wavelengths (Er, Cr:YSGG [2,780nm] and Er:YAG [2,940nm]) are the only ones that are absorbed by water, the primary component of standard irrigant solutions, and are therefore the smallest common denominator of all LAI approaches. (17 percent EDTA and 5 percent NaOCl). The energy required to achieve a molecule's absorption decreases as its absorption index for a wavelength increases. In particular, water absorbs laser Er:YAG energy three times better than Er:Cr:YSGG, requiring less power to produce the same effect.[10] The laser settings, including energy, pulse repetition rate, fluency, pulse duration, and peak power, must be taken into account in addition to the wavelength specificity (2,940nm and 2,780nm) for the target (water). It is also crucial to choose the right laser fibre or tip and position inside the tooth, including tip end design and diameter.[11]

Cleaning Efficacy of Laser Assisted Root Canal Irrigation: Since then, the use of laser-activated irrigation has evolved to involve inserting the tip early in the root canal procedure and using the laser to irradiate the irrigant solution to help clean the canal system.[10] Through what is referred to as a "transient cavitation" phenomenon, the laser's radiation is absorbed by fluid molecules and activates the irrigant.[10] Studies have shown that laser-activated irrigation greatly lowers bacteria levels, and some papers even show greater efficacy than other methods of activation.[11]The advantage of more efficient cleaning, which includes the elimination of smear layers, outweighs the risk of irrigant apical extrusion, which is present with all irrigant activation techniques.[12-17]

When performing LAI, the tip may be set in place, moved only slightly on the apical or middle third of the canal, or moved in, up, down, and towards the pulp chamber.[11] Since then, studies have looked into how the laser tip is positioned and whether it is better to move it near to the apex (as in earlier methods) or if a more coronal placement produces enough irrigant activation. According to the research, there is a chance for significant irrigant activation when the laser tip is positioned more coronally.[18,19]

LAI based System

Laser Pips: A technique for irrigation of the root canals that makes use of lasers. Sodium hypochlorite absorbs the laser, causing it to vaporize and produce vapor bubbles. As these bubbles grow and burst, they cause additional cavitational effects. The lasers employed can include diode lasers, Er: YAG, and Nd: YAG, which exhibit photochemical effects due to their high peak power and brief pulse duration.

The PIPS tip is 9 mm long, 600 microns in diameter, and 3 mm shorter at the head for lateral wave emission. The canal orifice is where the PIPS tip is stored.[25] According to Devito et al., PIPS is superior to traditional techniques. Noiri et al. and Llyod also demonstrated PIPS's ability to remove organic debris at a greater level but that the biofilm did not completely disappear.[20,21]

Photo Activated Disinfection: Reactive oxygen species are released when a photosensitizer (non-toxic dye) is inserted into the dental canal and is activated by low-intensity light. The dye adheres to the cell, releasing nascent oxygen and damaging the cell membrane when exposed to a particular light source. According to Komerik et al., the dye is believed to have reduced affinity for human cells. Besides being efficient against bacteria, photo activated disinfection (PAD) is also effective against fungus, viruses, and other organisms.[28] Toluidine blue is injected into the canal and let to sit for 60 seconds while being exposed to light for 30 seconds. Bunsor and Schlafer discovered that it effectively gets rid of micro-organisms. It should be seen as an addition to irrigation rather than a replacement.[22,23]

Single-Pulse SSP Laser-Assisted Irrigation: SSP/SWEEPS laser-assisted irrigation (LAI), which makes use of a unique type of Er:YAG laser and incredibly brief laser pulses to create photon-induced photoacoustic streaming of the irrigant throughout the intricate three-dimensional root canal system, is one of the most recent methods to increase the effectiveness of standard syringe root canal irrigation. The fast production of a vapor bubble at the fibre tip (FT) while it is immersed in the irrigant is caused by the high absorption of the SSP (Super Short Pulse; 50 s) Er:YAG laser pulse in the irrigant (approximately 1mm-thick fluid layer), which causes photon-induced photoacoustic streaming.

A vapor bubble starts to form at the end of the FT as a consequence of the fluid being immediately and locally heated past the boiling point. The rapid boiling causes the vapor bubble to start expanding. When it achieves its maximum volume and starts to collapse from the weight of the surrounding liquid, it is almost completely empty. The root canal volume experiences turbulent fluid circulation as a result of this phenomenon, significantly increasing the effectiveness of chemo-mechanical debridement.[24]

Dual-Pulse SWEEPS Laser-Assisted Irrigation: SSP laser-assisted irrigation has received a lot in terms of security and therapeutic efficacy. However, studies indicate that tailoring can lead to more advancements. This led to the creation of SSP/SWEEPS® endodontics, in which a dual-pulse SWEEPS® (Shock Wave Enhanced Emission Photoacoustic Streaming) approach is used to complement the highly successful single-pulse SSP irrigation. When using the SWEEPS method, a subsequent laser pulse is sent into the liquid at the ideal moment Topt, just as the initial bubble is about to burst, or just before t = Tosc. The first bubble's collapse and the collapse of secondary bubbles are accelerated by the growth of the second bubble, causing the emission of primary and secondary shock waves.[11]

LightWalker® - A highly capable system that provides the ability for the highest efficiency available in the sector Expanded dual-wavelength treatment choices with Er:YAG and Nd:YAG dental lasers, including the patented TwinLight® Endodontic and Periodontal Treatments. The industry-leading LightWalker AT model is the only dental laser system on the market with integrated scanner-ready technology, providing the utmost in ease and ergonomic comfort.[11]

SkyPulse®: an entirely new line of portable and compact Fotona dentistry lasers that will be customised for each and every practise. By allowing the selection of preset choices with a simple touch or the adjusting of treatment settings with a single swipe, the user-friendly, cutting-edge, and highly customizable interface of the SkyPulse offers unprecedented simplicity of use.[11]

Benefits of LAI over Conventional Irrigation [25-27]

1. It has superior chemical activation of NaOCl.
2. It has superior chemical dissolving of pulp residues by NaOCl.
3. It has superior physical disrupting impact on biofilm.
4. It has a better smear layer cleaning capacity than EDTA.
5. It has a superior bactericidal impact

Safety concern: One of the most crucial issues with using laser therapy is the safe usage of lasers. Interest is growing in this expanding subject due to the availability, application, and development of many laser wavelengths and pulse techniques. Diodes, Nd: YAG, erbium and CO2 lasers are class 4 lasers, which are considered high-powered dental lasers. They are hazardous to eyes and skin and require special precautions. Although many regulations and standards relating to laser safety are in effect, there continues to be an average of 35 laser injuries per year in United States. This can be attributed to unmonitored use of lasers in many solo practices.

Furthermore, the level of training and experience of dental staff is generally far less than that of the laser surgical nurse or hospital laser safety officer. Prior to any clinical or research application of a laser, the intended operator of the laser system must have a thorough knowledge of the operation and safety requirements of the specific laser system and should have received hands-on instructions related to its practical application. All the staff or other personnel present within the laser operating field should be well versed in the general safety practices applicable to the laser operation.[28]

Conclusion

Biofilms, pathogenic organisms, necrotic tissue, and hard tissue debris may be difficult to fully remove from the root canal complex during endodontic therapy. A few areas go unattended because it is difficult to access them all due to the intricate structure of root canal architecture. Mechanical instrumentation has left a smear coating that obstructs the ability of cleaning and disinfection to reach the abnormalities, fins, and isthmuses of the root canals. The root canal complex, including the isthmuses and fins, must be thoroughly cleaned and sterilized through irrigation. As a novel method of agitating intracanal disinfectants, LAI has recently gained popularity. Its result causes cavitation. By powerfully assimilating the laser energy, laser radiation causes temporary cavitation in the irrigant via optical breakdown. A well-known method of LAI is photon-induced photoacoustic streaming (PIPS), which uses a fiber tip to pulse at incredibly low energies to convey energy into the solution while only slightly raising dental temperature. It intensifies fluid exchange and the removal of debris by producing vapor bubbles with secondary cavitation effects.

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