The Use of Lasers in Disinfection of Root Canals: A Case Report

Ruchi Gupta[1], A Pritish Kumar Reddy[2], Priyansh Saxena[3], Martina George[4], Ayan Guin[5], Swati Saurabh[6], Anooja V Chandran[7]

[1]Professor, Dept of Conservative Dentistry and Endodontics, Divya Jyoti College of Dental Sciences and Research, Modinagar, Ghaziabad
[2,3,4,5,6,7] PG Student, Dept of Conservative Dentistry and Endodontics, Divya Jyoti College of Dental Sciences and Research, Modinagar, Ghaziabad

Corresponding Author: Dr. A Pritish Kumar Reddy, PG Student, Dept of Conservative Dentistry and Endodontics, Divya Jyoti College of Dental Sciences and Research, Modinagar, Ghaziabad

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INTRODUCTION

Effective root canal system disinfection and reinfection prevention are essential for the success of root canal therapy for teeth with periapical periodontitis.In the past, it was done using a combination of mechanical equipment and irrigation using disinfectant treatments.Instrumentation alone cannot provide a bacteria-free root canal, but it can reduce the bacterial burden by mechanically removing germs and diseased dentine tissue.Hence, a lot has been anticipated from different disinfection solution combinations.Due to its broad antibacterial spectrum of action and capacity to degrade organic tissue, sodium hypochlorite (NaOCl) at 0.5 to 5.25% is still regarded as the gold standard for root canal irrigation.Chlorhexidine, potassium iodine, MTAD (a combination of tetracycline, citric acid, and a detergent), and QMix (a combination of ethylene diaminotetraacetic acid, chlorhexidine, and detergent) are other antimicrobial irrigants that have been studied but have not yet been shown to be more effective than NaOCl.

Another important aim of the root canal irrigation is the removal of a smear layer (1 to 2 µm thick), which is formed on the root canal walls due to the preparation, and consists of dentine debris, pulpal remnants, bacteria, endotoxins. At the conclusion of mechanical instrumentation, the smear layer is eliminated by rinsing the root canals with 10 or 17% aqueous ethylenediamine tetra acetic acid (EDTA) or 10% citric acid, resulting in a tighter interface between the obturation materials and dentine walls.After removing the smear layer, a final rinse with a disinfecting solution is advantageous since EDTA and citric acid lessen the antibacterial activity of NaOCl.

In order to target lingering microorganisms and improve the healing rates of teeth with periapical periodontitis, new supplementary antibacterial therapy techniques have been advocated due to the complex intracanal anatomy and the limits of the syringe/needle irrigation methodology.Over the last two decades, different irrigant agitation techniques have been introduced as final irrigation protocols in endodontic treatment. Passive ultrasonic irrigation (PUI) and sonic activated irrigation have been reported to be efficient in the removal of the intracanal smear layer and debris and to facilitate the disruption of endodontic biofilms.

Lasers are a relatively new method of disinfecting and cleansing the root canals. Many laser wavelengths have already been studied for their impact on endodontic bacteria and root canal walls. Yet, there is still room for improvement in clinicians' adoption of laser technology.Nowadays, lasers can be employed in a number of endodontic treatments, including apical surgery, cleaning and sanitising the root canal system, obturation and endodontic retreatment.

The laser wavelengths described for cleaning and disinfecting the root canal system are: erbium: yttrium aluminium garnet (Er:YAG), 2940 nm; erbium, chromium: yttrium scandium galium garnet (Er,Cr:YSGG), 2780 nm; neodimium: yttrium aluminium garnet (Nd:YAG), 1064 nm; diode, 635 to 980 nm; potassium titanyl phosphate (KTP), 532 nm; carbon dioxide (CO2), 9600 and 10 600 nm.These lasers' physical impact on root canals depends on how well their wavelengths are absorbed by biological materials and chromophores like water, apatite minerals, and different coloured substances (microorganisms). When used with Nd:YAG, diode, and KTP lasers, electromagnetic radiation with visible and near-infrared wavelengths has stronger bactericidal effects on dentine than on water and hydroxyapatiteMid-infrared erbium lasers, on the other hand, have a superficial effect on dentine walls and can be used to remove the layer and disturb intracanal biofilms because their wavelengths are highly absorbed by water and hydroxyapatite.

There are a number of restrictions that must be taken into account while using lasers inside the root canal. First, a laser guide or optical plain-ended fibre's tip emits laser light in a straight line with a divergence angle of just 18 to 20 degrees.It is challenging to achieve equal irradiation of the entire root canal dentine surface with such a unidirectional laser beam. Furthermore, the potential of generating ledges and perforations makes root canal preparation and retreatment treatments using laser and plain fibres risky in curved root canals.While utilising fibre tips, a helicoidal withdrawal motion from the apical to coronal section is suggested to increase the surface area of the root canal dentine being irradiated. Aside from that, brand-new conical side-firing fibre tips with 80% lateral and 20% forward radiation completely cover intra-canal walls.Using erbium lasers at ablative settings might cause thermal injury to the peri radicular tissues through the open apical foramen, which is another restriction on the safe use of lasers in the root canal.

ND:YAG

The most extensively researched laser for endodontic disinfection is the 1064 nm Nd:YAG laser. The Nd: antimicrobial YAG's activity is based on local heating within bacteria and thermal heating of their surroundings (through chromophores inside bacteria sensitive to the laser light).The Nd:YAG laser's considerable bactericidal effect up to 1 mm into the dentine is its benefit in root canal disinfection. After Nd:YAG irradiation, Enterococcus faecalis and Escherichia coli levels in inoculation root canals were reduced by 99.16%, according to Moritz et al. Using the Nd:YAG laser at 15 Hz and 100 mJ, Gutknecht et al. were able to reduce the quantity of intracanal Enterococcus faecalis by an average of 99.92%.The Nd:YAG laser's tiny glass fibre tip, which has a diameter of around 200 m, must be positioned within 1-2 mm of the apex and advanced slowly in a circular motion to the crown in order to give even irradiation of the dentine walls and minimise heat injury to the periradicular tissues.

While melanin and darkly pigmented tissues absorb Nd:YAG laser irradiation better than water, it is less effective against nonpigmented bacteria (such Enterococcus faecalis) and bacterial biofilms, necessitating larger energy densities to produce a deadly thermal effect. Currently, the Nd:YAG laser's safety parameters are 15 Hz, 100 mJ, 1.5 W, four times for 5 to 10 seconds, with a 20 s gap between each repetition. Nd:YAG laser antibacterial impact has never been proven to be superior than traditional NaOCl irrigation. According to Bergman et al., Nd:YAG laser irradiation is not a substitute for current protocols for disinfecting root canals; rather, it may be used in addition to them.

Dentinal tubules may form with open or closed ends after intracanal dentine walls are exposed to the Nd:YAG laser, causing morphological alterations including melting and recrystallization. Nd:YAG radiation will have glazing, evaporation and surface contraction effects if the smear layer has not been removed.The complete removal of tissue remains, structural alterations, carbonization, and cracks are discovered at higher power settings (3W and above) as a result of thermal damage.

DIODE LASER

Diode lasers radiate in the infrared (810 to 980 nm) and visible (mainly 660 nm) regions of the electromagnetic spectrum. Diode lasers have a shorter penetration depth into the dentine (up to 750 m) than Nd:YAG lasers due to the higher absorption coefficient in water (0.68 cm-1) for diode lasers.Only a limited amount of information about diode lasers' antibacterial efficiency in root canal therapy is currently accessible in the literature. A diode laser (810 nm) operating at 3 W for 5 × 5 s against intracanal Escherichia coli and Enterococcus faecalis in removed teeth was shown by Moritz et al. to have bactericidal effects. Although causing a 6°C temperature rise, irradiation at 4 W was even more effective. Gutknecht et al. obtained the same outcome when using a diode laser (810 nm) at 3 W for 30 s to treat intracanal Enterococcus faecalis.A diode laser (985 nm, 2 W, 3x20 s) had a similar anti-E. faecalis biofilm impact as using 2.5% NaOCl for 60 s in a study by Bago et al.

Morphological changes in the dentine walls after diode laser irradiation are similar to those obtained with a Nd:YAG laser (disruption and melting of the smear layer, closed and opened dentinal tubules)

CASE REPORT

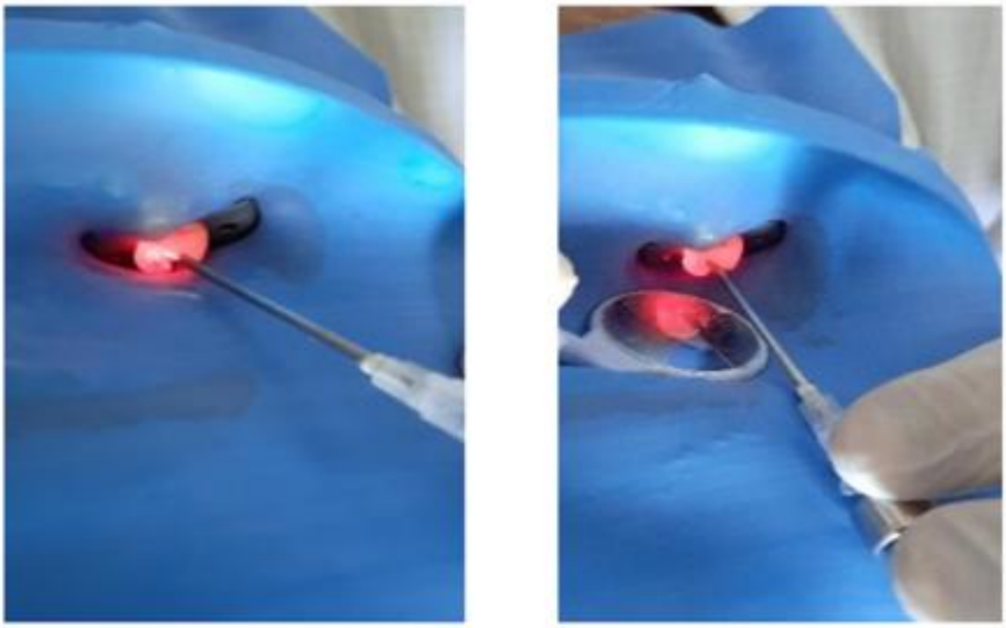
A 45-year-old male patient reported with a chief complaint of pain in lower right back teeth region since last 1 months. The medical history of the patient was non-contributory. The teeth was not mobile.

Pulp vitality test with electric pulp tester (EPT) showed that tooth 36 was vital. Thermal tests with heated Gutta-percha (GP) and pencil ice sticks gave a positive response.

Root canal treatment was planned. Local anaesthesia was administered with 2% lignocaine (1:80,000 epinephrine). After the rubber dam application and access opening, a #10 stainless steel hand k-file was used to establish the glide path.The working length was obtained using -the canal pro CL2I apex locator (coltene)and was confirmed using an intraoral periapical radiograph. Mechanical preparation was performed up to size 25 using a stainless-steel hand k-file.Intermittent irrigation done with sodium hypochlorite.

Intense Medical and dental system (IMDSL) laser (980 nm) was used for canal disinfection. Laser cord was adjusted up to the working length and power was adjusted at 3.0W. After taking safety measures of both patient and dentist, cord was inserted and canal disinfection was done for 30 seconds.

On the next visit biomechanical preparation and obturation was done. Post endo restorationwas done. On recall the patient was asymptomatic.



Canal Disinfection Using Leser Tip

DISCUSSION

The root canal procedure's long-term success is attributed to the efficient removal of the bacteria that cause inflammation in the root canal and in the dentin tubules. One of the primary causes of endodontic treatment failure is the bacterial contamination of root canals and subsequent spread of the bacteria in soft tissue remains of necrotic tissue.While receiving a root canal filling, teeth that produce a negative culture for bacterial growth have a better success rate than teeth that produce a positive culture.In addition to mechanical instrumentation of the root canal system, irrigating the canal with disinfectant chemicals has been suggested to improve the elimination of bacteria and bacterial by-products as well as vital and non-vital tissue remnants and products of tissue breakdown.The root canal system can only be disinfected to a limited extent by sodium hypochlorite and calcium hydroxide (about 130 m penetration). Pure $Ca(OH)_2$ in a water vehicle is less effective in dentinal tubules than chlorhexidine and iodine-potassium-iodine, but total disinfection has not been proven.

Bacteria have been found to invade the periluminal dentine as deep as 1,100 m, according to research. Chemical disinfectants only penetrate 100 m into the dentine, according to Berutti et al. Moreover, endodontic therapy may be hampered by curved root canals or lateral canals.Laser technology is used to address this issue. The best explanation for the proper bactericidal impact of various laser wavelengths appears to be the great penetration efficiency of the laser light in the dentinal tissue.The best explanation for the gratifying bactericidal action of various laser wavelengths appears to be the high laser beam penetration depth in the dentinal tissue.It was recommended that newer treatment approaches intended to get rid of microorganisms from the root canal system be taken into consideration because the majority of currently used intra-canal medications have a restricted anti-bacterial spectrum and a restricted ability to diffuse into the dentinal tubules.

They must contain substances that can enter dentinal tubules and eliminate microorganisms that are outside the range of the host's defence mechanisms and are therefore inaccessible to antibacterial medications that are provided consistently.Several investigations have demonstrated that emitting laser light directly into the root canal does really have this bactericidal effect. The ability of quartz optical fibres to carry laser radiation may make it easier to introduce laser light around imperfections and curvatures in canals.A plausible explanation for this type of light propagation is given by Vaarkamp and colleagues as well as Odor and colleagues, who detail how enamel prisms and dentin tubules can function as optical fibres.Since that direct contact between the target and fibre tip is not necessary and that laser light has the properties of being monochromatic, coherent, and directed, it is possible that dentin-deep regions might be cleaned using laser energy.

CONCLUSION

There is general agreement that laser irradiation has the potential to eliminate debris and smear layer from root canals as well as kill germs. There isn't enough data to say that any particular laser is better than the standard endodontic procedure for cleaning root canals.Root canal debridement and cleaning can be done using Erbium and Nd:YAG wavelengths; Erbium lasers can be used for laser activated irrigation and photon started photoacoustic streaming, while Nd:YAG lasers can be utilized to evaporate and constrict the smear layer.Finally, the use of laser is advised as an additional method of disinfection and debridement rather than as a replacement for NaOCl. To assess the effectiveness of laser-assisted endodontic treatment, more clinical randomized studies are required.

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