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ORIGINAL RESEARH

Evaluation of antimicrobial efficacy of diode lasers- An invitro study

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***ABSTRACT*:**
Background: The outcome of root canal treatment of teeth depends on efficient disinfection of the root canal system and prevention of re-infection. The present in vivo study was conducted to evaluate the role of laser with respect to its antimicrobial efficacy. **Materials & Methods:** The present study was conducted on 30 patients of both genders. Patients were divided into 3 groups of 10 each. In group I, diode Laser was used for disinfection. In group II, the root canal was irrigated with 5% sodium hypochlorite solution followed by 810nm Diode Laser. In group III, the root canal was irrigated with 2% Chlorhexidine solution followed by 810nm Diode Laser. Root canal treatment was done following standardized procedures. The root canals were irradiated with a 810 nm diode laser by Denlase, The post-treatment microbiologic samples were collected immediately after the procedure. **Results:** In group I, diode Laser was used for disinfection. In group II, the root canal was irrigated with 5% sodium hypochlorite solution followed by 810nm Diode Laser. In group III, the root canal was irrigated with 2% Chlorhexidine solution followed by 810nm Diode Laser. Pre-treatment microbial count in group I was 25.18 CFU/mlx10^3 which reduced to 7.2 CFU/mlx10^3 in group I. In group II, it was 22.7 CFU/mlx10^3 which reduced to 4.5 CFU/mlx10^3 and in group III, it was 22.6 CFU/mlx10^3 which reduced to 2.7 CFU/mlx10^3. There was 74.5% reduction in microbial count in group I, 81.3% in group II and 85.8% in group III. **Conclusion:** Diode lasers are useful in disinfecting root canals. The root canal was irrigated with 2% Chlorhexidine solution followed by Diode Laser found to be effective.

Key words: Chlorhexidine, Diode lasers, Root canal.

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INTRODUCTION

The outcome of root canal treatment of teeth depends on efficient disinfection of the root canal system and prevention of re-infection. However, conservative chemomechanical treatment for canal preparation and enlargement fails to provide complete removal of bacteria. The selective efficacy of different root canal disinfecting agents against different microorganisms is another barrier in the way to achieve complete disinfection of root canal.[1]
Although instrumentation alone may reduce bacterial load by mechanical removal of microorganisms and infected dentine tissue, it does not provide a bacteria free root canal. Therefore, much has been expected from various combinations of disinfecting solutions.[2] Sodium hypochlorite (NaOCl) at 0.5% to 5.25% is still considered the gold standard for root canal irrigation due to its wide antimicrobial spectrum of action and ability to dissolve organic tissue. Other antimicrobial irrigants such as chlorhexidine, potassium iodine, MTAD (a mixture of tetracycline, citric acid and a detergent) and QMix (a mixture of ethylenediamino tetraacetic acid, chlorhexidine and a detergent) have been investigated, but still not proven to be more effective than NaOCl.[3]
Diode lasers that emit radiation within the visible (mostly 660 nm) and infrared (810 to 980 nm) range of the electromagnetic spectrum have emerged as an alternative to chemomechanical disfinfection of root canal.[4] The present in vivo study was conducted to evaluate the role of laser with respect to its antimicrobial efficacy.

MATERIALS & METHODS

The present study was conducted in the department of Endodontics. It comprised of 30 patients of both genders. Thos patients who had carious teeth indicated for root canal treatment were enrolled in the study. All were informed regarding the study and written consent was obtained. Ethical clearance was obtained prior to the study.

General information such as name, age, gender etc. was recorded. Patients were divided into 3 groups of 10 each. In group I, diode Laser was used for disinfection. In group II, the root canal was irrigated with 5% sodium hypochlorite solution followed by 810nm Diode Laser. In group III, the root canal was irrigated with 2% Chlorhexidine solution followed by 810nm Diode Laser.

Root canal treatment was done following standardized procedures. Sterile 40 K-file was used for sampling from the apical part by reaming for 20 seconds. Sterile paper points were used to collect the transfer fluid and dentin chips. Sterile paper points and sampling H & K-files were placed into a test tube containing 10 ml of sterile saline. It was vortexed for 20 seconds. 50 microlitres of vortexed saline was applied to tryptic soya agar. The sample was then incubated at 37^{o}C for 48 hours. CFU/ml for each plate was calculated using a bacterial colony counter.

This procedure was followed by the actual laser treatment. The root canals were irradiated with a 810 nm diode laser by Denlase, The post-treatment microbiologic samples were collected immediately after the procedure. Results thus obtained were subjected to statistical analysis. P value less than 0.05 was considered significant ($P< 0.05$).

RESULTS

Table I Distribution of patients

Groups	Group I	Group II	Group III
Technique	Diode Laser	5% sodium hypochlorite solution & Diode Laser	2% Chlorhexidine solution & Diode Laser
No.	10	10	10

Table I shows that in group I, diode Laser was used for disinfection. In group II, the root canal was irrigated with 5% sodium hypochlorite solution followed by 810nm Diode Laser. In group III, the root canal was irrigated with 2% Chlorhexidine solution followed by 810nm Diode Laser.

Table III Mean pre-and post-treatment Microbial count and % Reduction in microbial count in different groups

Groups	Pre treatment (mean± SD) CFU/mlx10^3	Post treatment (mean± SD) CFU/mlx10^3	% Reduction
Group I	25.18	7.2	74.5%
Group II	22.7	4.5	81.3%
Group III	22.6	2.7	85.8%

Table III, graph I shows that pre-treatment microbial count in group I was 25.18 CFU/mlx10^3 which reduced to 7.2 CFU/mlx10^3 in group I. In group II, it was 22.7 CFU/mlx10^3 which reduced to 4.5 CFU/mlx10^3 and in group III, it was 22.6 CFU/mlx10^3 which reduced to 2.7 CFU/mlx10^3. There was 74.5% reduction in microbial count in group I, 81.3% in group II and 85.8% in group III.

DISCUSSION

In endodontics eradication of microorganisms is the primary goal and also serves as predictor for the long-term success of the endodontic therapy. Root canal irrigation plays an important role in the debridement and disinfection of root canal systems. Many clinical approaches have been evaluated for disinfection and control of the root canal biofilm during endodontic treatment. Even then the presence of bacteria in root canals has been considered to be responsible for endodontic treatment failure. Location, harbouring, and multiplication of bacteria within root canals are the factors most crucial for disinfection. Therefore, the disinfection in this anatomical structure poses to be a clinical problem.[5]

Biomedical applications of lasers have been under investigation since Theodore Maiman used the first Ruby laser in 1960. Commercially available medical laser wavelengths cover a short band in the electromagnetic spectrum, ranging from ultraviolet (UV) to mid-infra-red (IR) (approximately 200 nm to 10 µm). The laser beam is, due to its monochromaticity (single wavelength), coherence (photons in phase), collimation (very low beam divergence) and intensity, highly precise and selective in interaction with biological tissues. Diode lasers have higher absorption coefficient in water (0.68 cm-1), diode lasers have lower penetration depth into the dentine (up to 750 µm), hence they can be considered to be safer and more effective for the purpose of root canal treatment.

A number of in vitro studies have shown them to be effective in root canal treatment, however, there is dearth of in vivo studies enquiring this efficacy.[6] The present in vivo study was conducted to evaluate the role of laser with respect to its antimicrobial efficacy.

We observed that pre-treatment microbial count in group I was 25.18 CFU/mlx10^3 which reduced to 7.2 CFU/mlx10^3 in group I. In group II, it was 22.7 CFU/mlx10^3 which reduced to 4.5 CFU/mlx10^3 and in group III, it was 22.6 CFU/mlx10^3 which reduced to 2.7 CFU/mlx10^3. There was 74.5% reduction in microbial count in group I, 81.3% in group II and 85.8% in group III.

Radaelli et al[7] conducted a study on sixty freshly extracted primary teeth either single or multi-rooted teeth with two third of their root length intact were collected. Instrumentation was completed to size 30 H-file. Teeth were randomly divided into Group 1- Direct Laser-irradiation, Group 2 - Photodynamic therapy; Group 3- Laser activated irrigation with 2.5% NaOCl. The tooth specimens were inoculated with Enterococcus faecalis. The bacterial colonies were counted preoperatively. Laser irradiation was performed for all groups in accordance to the groups each tooth belonged to. Postoperatively the bacterial colonies were counted. The results obtained with all the three groups postoperatively were highly significant (p-value<0.001). Statistically significant difference between results of Group 1 and Group 2 and also between Group 1 and Group 3 was found (p-value$\leq$ 0.001). However, no statistical difference between Group 2 and Group 3 was found.

Potential benefit of lasers in medicine and dentistry depends on the particular properties of each type of laser and the specific target tissue. The physical properties of the tissue (absorption and scattering coefficient, thermal conductivity, mechanical strength, heat capacity) and laser irradiation parameters govern the course of laser-tissue interactions. At low irradiances and/or energies, laser tissue interactions are either purely optical, or a combination of optical and photochemical or photobiomodulative effect. When laser power is increased, photothermal interactions start to dominate.[8]

CONCLUSION

Diode lasers are useful in disinfecting root canals. The root canal was irrigated with 2% Chlorhexidine solution followed by Diode Laser found to be effective.

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