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A Revolutionizing Purview of Diode Laser in The Endodontics –An in Vitro Study

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Abstract

Laser in dentistry is most widely accepted mode of treatment in various specialties including endodontics. The aim and objective of the study was to evaluate and compare the antimicrobial efficacy of a diode laser irradiation and chlorhexidine in the root canal treatment against enterococcus faecalis, gram positive, facultative anaerobic bacteria in single-rooted canals after rotary method of bio mechanical preparation Single rooted teeth were selected, biomechanical preparation was done. The teeth were inoculated with Enterococcus faecalis. They are disinfected with, Chlorhexidine and Diode laser. The antimicrobial efficacy was evaluated under spectrophotometer. The results were statistically significant with p-value <0.05. The P-value for samples indicates that there is sufficient evidence and to explore the differences among the means of the samples. The efficacy of diode laser is found 73% whereas 90% with chlorhexidine. The study concluded that application of Diode laser and clorhexidine has antibacterial effect against Enterococcus faecalis.

Keywords: Enterococcus Faecalis, Root Canal Treatment, Disinfection.

Introduction

The foremost objective of endodontic treatment is eradication of debris, microbial load and their byproducts from the tooth complex system. Chemomechanical preparation plays a main role although, according to

literature & studies showed that due to the complex anatomy of the root canal systems the dentinal walls may remain untouched after mechanical preparation[1]. Enterococcus faecalis are the Gram-positive, non-sporing, facultative anaerobe that is usually found in chronic periodontitis and root canal retreatment cases predominant microorganism found in infected root canals[2]. E. faecalis. Biofilm is a community of micro-organisms that are firmly attached to the surface and encased in a self-made extracellular polymeric substance. The use of antibacterial root canal irrigants is mandatory to achieve success of the endodontic treatment. Commonly used root canal irrigtants cause adverse effect on the physical properties of dentin and also bacterial resistance is increasing with these irrigants Thus, a continuous search for alternative protocols for enhancing disinfection is needed. It was proven that high power diode laser is capable of disinfecting the root canal system and has the ability to reach the complex anatomical structures.

The advantages of using the laser are balanced by several significant disadvantages. Multiple laser systems can be used as auxiliary tools to promote root canal disinfection. Laser beams can penetrate deeply into the dentinal tubules without being absorbed by the hard tooth tissue, leading to a reduction in the bacterial population by 63% at a depth of 750 µm

Methodology

Single rooted teeth extracted due to the periodontal reasons with prior consent of the patient were collected. Endodontic access was achieved using endo access bur & the patency was checked. Working length was taken at 1mm short of apical foramen. Biomechanical preparation was done with Protaper Gold files. The canals were washed with NaOCL(Pyrax), distilled water and with EDTA.[1] To unlock the smear layer kept for 5 mins in NaOCl. All canals washed with 5ml of normal saline. Teeth were mounted in self cure acrylic resin in microtubes and autoclaved at 121˚C for 15 lbs for 15 min[1].

Groups samples were divided into three groups 10 teeth in each group including the control groups. n=10

The autoclaved samples were inoculated with Enterococcus faecalis and incubated at 37˚ C for 24 hrs respectively. Enterococcus faecalis secured from Research Institute, Chandigarh. These prepared strains were used.

Autoclaved teeth with prepared root canal were inoculated with strains of Enterococcus faecalis 10^6 CFU / ml and incubated at 37˚C for 24 hrs. Sample from each root canal was taken with the help of a sterile paper point, prior to the treatment and put into the nutrient media. The turbidity was evaluated. The optical density was observed at 600nm in a spectrophotometer.

The n=10 samples of each 3 groups which were inoculated with Enterococcus faecalis were disinfected with Laser, Chlorhexidine and normal saline separately. Post treatment samples from each root canal were taken with the help of a sterile paper point, and transferred into the nutrient media. The vials were further incubated for 24hrs at 37˚C and were observed for inhibition.

The BIOEPIC LASER 940+10µm wavelength, each root canal irradiated with head diameter of 200µm & 1mm shorter than the apex continuously with rotational & epicoronal motions for 30 sec. Tips used of 20mm length (1mm short of apex). Every time it is repeated 3 times giving rest for 10 sec between the laser irradiation. Pre-treatment and Post treatment samples were taken and percentage inhibition & optical density was calculated.

The similar methodology was followed with the Chlorhexidine (2%, Neelkanth). Statistical Analysis done by ‘Statistical Data Analysis’ Comparison between the

two groups is done by t-paired test (p<.001) shows significant. Mean Inhibition percentage was calculated.

Figure 1: Disinfection of sample with diode laser and chlorhexidine

Results

The results of the study was found with the disinfection done with the Diode Laser is percentage inhibition -73.53% and chlorhexidine percentage is 90%. The diode laser also shows the significant reduction in the microbial count.

Table 1: Mean of OD Preswab and Postswab taken of Diode Laser

Sample	OD Preswab	OD Postswab	% Inhibition(α)
L1	0.701	0.184	73.75
L2	0.712	0.176	75.28
L3	0.725	0.177	75.59
L4	0.709	0.178	74.89
L5	0.723	0.169	76.63
L6	0.734	0.208	71.66
L7	0.699	0.196	71.96
L8	0.72	0.204	71.67
L9	0.732	0.192	73.77
L10	0.706	0.211	70.11
		Mean	73.53

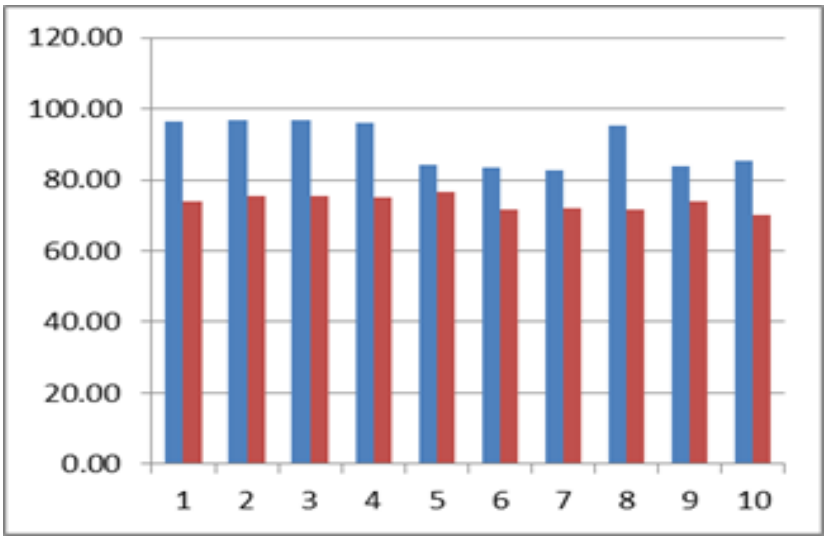
Table 2: Mean of OD preswab and postswab taken of CHLOROHEXIDINE

Sample	OD Preswab	OD Postswab	% Inhibition(α)
CHLOR1	0.711	0.026	96.34
CHLOR2	0.812	0.027	96.67
CHLOR3	0.788	0.025	96.83
CHLOR4	0.76	0.029	96.18
CHLOR5	0.807	0.129	84.01
CHLOR6	0.765	0.126	83.53
CHLOR7	0.731	0.128	82.49
CHLOR8	0.811	0.037	95.44
CHLOR9	0.801	0.13	83.77
CHLOR10	0.734	0.108	85.29
		Mean	90.06

Table 3: Comparison of mean percent inhibition of Chlorhexidine and Diode laser

% Inhibition(α)	Laser	Chloro
Mean	73.53	90.05
Standard Error	0.66	2.09
Median	73.76	90.36
Standard Deviation	2.10	6.61
Range	6.51	14.33
Minimum	70.11	82.49
Maximum	76.62	96.82
Sum	735.31	900.55
Count	10	10
Largest(1)	76.62	96.82
Smallest(1)	70.11	82.49
Confidence Level (95.0%)	1.50	4.73

Graph 1: Comparison graph showing individual samples inhibition.



X axis shows - Samples

Y axis shows-Percentage inhibition mean

According to the results of tukey hoc test, intercomparison of the group is done, there was a significant decrease in the number of bacterial colonies after the intervention ($p < 0.05$) and present descriptive values of *E. faecalis* colonies before and after the intervention and reduction percentage of colony count.

Highest reduction percentage of E. faecalis colonies was observed in the Chlorhexidine group, indicating that this disinfectant acted as the best disinfectant with an efficiency of 90%, and with the diode laser group with an efficiency of 73.5%.

Discussion

Success of endodontic treatments is related to disinfection of root canal system. E. faecalis is a Gram positive coccus which is very frequently found in canals needing retreatment. Special attention to this

microorganism is because of its resistance against intra canal medicaments such as calcium hydroxide. The laser used in the study was diode laser as it has favorable antibacterial properties and relative safety and also more suitable price, this kind of laser has gained popularity.

Numerous studies have proven that the bactericidal effect of a diode laser (810 nm) is based on thermal properties; furthermore, bacteria cannot develop resistance to laser exposure.[4,5]

Although some in vitro studies have shown higher antibacterial efficiency of CHX than NaOCl, in in vitro environment, dentinal components can reduce the efficiency of CHX. The present study is in agreement with Eldeniz et al., who compared the efficacy of Er, Cr: YSGG and NaOCl against E. faecalis. Results showed %100 elimination of bacteria by %3 NaOCl; whereas efficacy of laser was significantly lower. The diode laser technique has been performed in endodontics treatment for a decade. It is well known that different parameters of lasers and fibers, the output power of the laser, and the duration of application have different effects on disinfection[5].

The thermal effect is the most important point to be considered in laser applications. A temperature rise to a critical level could have deleterious effects on the tissues surrounding the tooth. The temperature increases by approximately 10 °C and a treatment duration of 1 min can cause irreversible injury to periodontal tissues. Gutknecht et al.[12] demonstrated that diode laser irradiation for 5 s, with 10 s of resting time, should be considered to avoid a temperature rise to an undesired level. Schoop et al. [22] also drew similar conclusions that a diode laser showed the lowest temperature increases compared with other laser devices and was suitable for the disinfection of root canals. Therefore, according to the information, we adopt a safe mode of diode laser to perform root canal therapy. Several studies have shown that a 3.0 W diode laser with an 810-nm wavelength could eliminate bacteria when used on permanent teeth[4].

Kimura et al. suggested that although removal of debris and smear layer is possible by laser, it is difficult to clean all of root canal walls because the laser energy is emitted straight ahead, making it almost impossible to irradiate the lateral canal walls[13,14]. Using side firing tips may enable the lasers to irradiate all areas of root canal walls and increase. There is a direct relation between disinfection of root canal system and success of endodontic treatments. therapy has shown great promise in removal of the smear layer, bacteria and infection in endodontics. Studies have shown that conventional instrumentation together with irrigant solution can only remove partially[14]. Diode laser wavelengths balance between absorption and penetration to bring energy below dentinal surface without tending to damage it. Diode laser energy is able to activate chemical irrigants to increase their bactericidal effects.

Conclusion

The diode laser is a boon to the dentistry and can be combine with other adjunct as a it has the antibacterial activity and help in the root canal disinfection.

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