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ABSTRACT

Aims: The purpose of this study was to estimate the bactericidal effect of erbium, chromium: yttrium scandium gallium garnet 2,780nm (Er,Cr:YSGG) on contaminated sand-blasted, large grit, acid-etched (SLA) dental implant and determine the parameter that effectively detoxify the surface of implant ailed with peri-implantitis before regenerative therapy of the area. Material and Methods: Implants (3.4*10mm) with SLA surfaces fixed with Enterococcus faecalis and irradiated with Er,Cr:YSGG lasers. After laser treatments, the number of remaining colony-forming units (CFUs) counted. The entire implant surface exposed uniformly in constant time and different energies. six powers were used (0.25, 0.5, 0.75, 1, 1.25, 1.5watt ) at 20 Hz, water 20%, air 40% with movable motions on each thread for 30 second and in non contact mode at 2 mm distance between MZ10 tip and target with H mode. Results: laser showed total bacteria reduction on the implants irradiated with 1.5W. Significant differences between measurements in the different gr-0.05 were observed, depending on the used power. Conclusions: Er,Cr:YSGG Laser can be used at above parameter safelyon implant surface as disinfection tool in treatment of peri-implantitis.

Key words: Er,Cr:YSGG laser, dental implant, peri-implantitis.

INTRODUCTION

Dental implant is a largely standard treatment opportunity for replacing missing teeth(1). However, biological and mechanical complications may occur during implant treatment, and may lead to implant failure if no management can be established(2).
Implant failure has naturally been attributed to bacterial infection, premature fixture overload, surgical trauma, faulty or incorrect prosthetic design, and/or improper surgical placement. The etiology of failure is thought to be infection, if there is pain, suppuration, and high plaque, bleeding, and gingival indices. This infectious process with progressive bone loss seen over time is categorized as peri-implantitis (3).

The term Peri-implantitis was introduced by Mombelli et al. and he suggested that “Peri-implantitis” is a site specific infection which yields many features in common with chronic adult periodontitis (4).

A current consensus report concluded that peri-implantitis is a bacterially induced inflammation of the supporting peri-implant tissues leading to non-reversible bone destruction (5).

The progression of bacterial colonization of the implant surface is complex and involves many stages and bacteria species, however the bacteria in peri-implantitis showed a more complex type when compared to periodontally healthy teeth and periodontitis (6).

Numerous treatments recommended for peri-implantitis. In case of ailing implant, one must first realize the cause of the problem. The main complexity in the treatment of peri-implantitis is in obtaining effective decontamination of the implant surface due to the rough surfaces. However these surfaces, even though highly beneficial for the initial process of osseointegration (7) promote a larger accumulation of peri-implant biofilm (8).

The researchers described physical method (plastic curettes ,scaling, ultrasound) (9), local chemical (antibiotics , antiseptic solutions) (10), systemic methods (11) or a combination of these (12, 13).

Decontamination combined with regenerative techniques is fundamental for the remission of peri-implantitis (14, 15).

Perfectly, bone-to-implant contact should be increased and implants should become reosseointegrated. Currently, there is no confirmation about the efficacy of anti-infective treatment to prolong the durability of an implant. There is also insufficient evidence to support any specific treatment strategy with respect to treatment of peri-implantitis (16).

The use of laser for decontaminating periodontal pockets has been shown to be effective and has encouraged research for determining or clarifying its effectiveness in the treatment of peri-implantitis (17).

MATERIALS AND METHODS

Tools and Specimens

Seventy dental implants with SLA surface were used in this study (D3.4 L10 mm), (Dentium Co. Ltd, Suwon, Korea). Er, Cr: YSGG (Biolase, Iplus type, Dental Laser, USA) was used for laser treatments of implant surfaces. Max Milling Machine from BioArt Company (made in Brazil) used for fixation of laser and micromotor handpiece in standard manner. NSK motorsystem (Japan made) used for rotation of implant in constant speed and time. An acrylic holder was fashioned for the motor hand piece, which remained in a stable position Figure. (1).
Laser device

The Er,Cr:YSGG laser (Iplus, Biolase, USA), emitting at 2.78 μm and pulsating for a duration of 60 μsec (H mode) and a repetition rate of 20 Hz, water 20, air 40 was employed in the present study. The delivery of laser system consisted of a fiber-optic tube that terminates in gold hand piece type with MZ10 tip (1mm diameter). The beam spot size at the tip was 1mm, and the exposure time was 30s for each thread at speed 25 RPM and the distance between implant and tip of laser is 2mm Figure.(2).

Incubation of implant with bacteria

Culture media preparation

Enterococcus faecalis agar media (HiMedia, India) was prepared by adding 42gm of powder to one litter of distilled water in glass flask with continuous mixing with glass road until completely dissolved in water. The mixture heated to 85°C without boiling, the flask removed from the heater, left to become warm, and poured in...
disposable petri-dishes in a septic condition in hood with the presence of gas burner. The petri-dishes cooled and kept in refrigerator until used. Enterococcus faecalis bacteria obtained from Microbiology Department, College of Dentistry, University of Mosul. Bacteria inoculated on Enterococcus agar and incubated aerobically for 18h. One colony of fresh bacteria inoculated in 5 ml screw capped vial containing nutrient broth(lab49, England) incubated for 18h. Bacterial suspension of 0.5 ml added to 0.5 ml of nutrient broth in screw-capped vial. The vial shook well manually in vertical direction, the final dilution of inoculated broth become 4X10^7 CFU/ml. Then for purpose of bacterial count, the bacterial suspension was added to 4 ml of normal saline and this incubated broth placed inside the container of the sterile implant to the level of neck of implant and then incubated at 37°C for 18h this will lead to fixation of bacteria inside the rough surface of implant Figure.(3) (19)

Figure(3): Dental Implant in a plastic container with the bacterial solution.

Figure(4): Bacteria reduction by laser from left to right the power is 0.75, 1, 1.25 watt respectively
At the end of the incubation periods, the bacterial growth was checked for the purpose of analyzing and counting the number of CFU to determine the reduction of the microbial population of the irradiated implants. The solid medium used for evaluating the number of CFUs is M-Enterococcus India Agar Base, which is highly selective media, (HiMedia Laboratories M1108).

**Laser treatment**

The contaminated implant are divided into 7 groups according to laser exposure level this include (0.25, 0.5, 0.75, 1, 1.25, 1.5 watts) in addition to control that was not treated by laser, each group include 10 implants. The contaminated implants removed from its container, fixed in hand piece and rotated at 25 RPM. The hand piece of laser fixed in milling machine as shown in the figure,(2), and each millimeters of implant exposed to laser for 30s so all the implants surfaces exposed uniformly to laser.

After irradiation, each implant removed from the device using sterile tweezers and introduced in sterile test tubes containing 5ml of normal saline then the tube shook well manually in a circle manner for 1 minute. Then 0.5ml of this saline aspirated by insulin syringe and distributed on the Enterococcus faecalis agar media by sterile cotton swab. This dilution calculated in pilot study with the purpose of counting the number of CFU to determine the reduction of the microbial population of the irradiated implants. The Petri-dishes incubated for 24 hour at 37\(^\circ\)C then counting of colony started. This procedure repeated 5 times for each sample then the mean was calculated.

Plastic cover used to cover the field of work during laser exposure to prevent contamination from outside. This procedure was repeated for each treated fixture but with different laser power.

**RESULTS**

From the CFU counts of the laser treated and the control specimens, the reduction mean were determined by using a software package (SPSS 11, SPSS Inc., Chicago, IL, USA) by calculating the number of colonies after each laser group radiation. Mean values and standard deviations calculated for each group. Analysis of variance (ANOVA) and post hoc testing using Duncan for comparisons within and between groups. Results were considered statistically highly significant at p<0.001,(Tables 1and 2).
Table (1): Analysis of variance of bacterial reduction (ANOVA)

<table>
<thead>
<tr>
<th>Bacteria</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>12501392.326</td>
<td>6</td>
<td>2083565.388</td>
<td>5901.192</td>
<td>.000</td>
</tr>
<tr>
<td>Within Groups</td>
<td>22243.748</td>
<td>63</td>
<td>353.075</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>12523636.074</td>
<td>69</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table (2): Duncan test that compare between and within the groups of bacteria show significant difference of bacterial reduction at \( p<0.001 \).

<table>
<thead>
<tr>
<th>Group</th>
<th>No.</th>
<th>Mean Bacteria± SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.5 WATT</td>
<td>10</td>
<td>.000000 ±0E-7</td>
</tr>
<tr>
<td>1.25 WATT</td>
<td>10</td>
<td>20.060000 ±2.4891766</td>
</tr>
<tr>
<td>1 WATT</td>
<td>10</td>
<td>66.020000 ±27.5233154</td>
</tr>
<tr>
<td>0.75 WATT</td>
<td>10</td>
<td>248.060000 ±20.3373876</td>
</tr>
<tr>
<td>0.5 WATT</td>
<td>10</td>
<td>915.020000 ±15.1679340</td>
</tr>
<tr>
<td>0.25 WATT</td>
<td>10</td>
<td>922.660000±25.5899373</td>
</tr>
<tr>
<td>control</td>
<td>10</td>
<td>934.960000 ±20.2306258</td>
</tr>
<tr>
<td>Duncan group*</td>
<td></td>
<td>A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>B</td>
</tr>
<tr>
<td></td>
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<td>C</td>
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<td></td>
<td>E</td>
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<td></td>
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<td>EF**</td>
</tr>
</tbody>
</table>

*Means with different letter were statistically significant at \( p\leq0.001 \)

There was complete eradication of bacteria at 1.5 watt. The eradicated bacteria represented in (Figure 5). No statistically significant differences observed in groups treated with 0.25 and 0.5 watts.

![Figure 5: Mean bacterial reduction in different power laser power](image)
DISCUSSION

In this study, E. faecalis (gram-positive facultative anaerobic microorganism) was chosen as the test microorganism because it is one of the most resistant microorganisms in the oral cavity\(^\text{20, 21}\). The utilization of different types of lasers for the decontamination of periodontal pockets, bone surfaces, may consider a new field in peri-implantitis management. The decrease of microorganisms by the laser action, although confirmed by multiple studies, has some aspect when used for the treatments of peri-implant disease, as in many cases the laser action may affect the implants' titanium surface\(^\text{22-25}\). So the type of laser and its parameter should always be detected to avoid the negative changes that may affect on the process of osseointegration. The results in the present study showed that the group treated with 1.5 watts for 30 seconds can decontaminate the rough implant surface according to the methodology that were used.

The findings presented by Cheng et al. can be demonstrated at 1 Watt and 1.5 Watt, the Er,Cr:YSGG laser was able to reduce E. faecalis by 77% and 96% respectively however the condition of his study is different but it can give us the power that can be used with bacteria\(^\text{26}\). Regarding to the accidental effect of this laser on bone during disinfection procedure of implant, there are many studies that can give us clue about this effect so the study presented by Lee, C. Y. during osteotomy revealed vital lamellar bone, especially at the lased margins with no microscopic evidence of inflammation or osteoclastic activity\(^\text{27}\).

Other study demonstrated by Kimura et al. showed that the Er,Cr:YSGG laser cuts canine mandibular bone effectively without burning, melting, or altering the calcium: phosphorus ratio of the irradiated bone in spite of using 5 watt as a cutting power \(^\text{28}\).

Regarding to the effect of this laser on surface topography, the parameter that were used can be considered safe and within the limit as surface decontamination tool and this can be seen in a study done by Schwarz et al. when failed to demonstrate any visible morphological differences between irradiated and non-irradiated control titanium surfaces. In particular, no thermal side effects, such as melting or loss of porosity \(^\text{29}\).

CONCLUSION

The Er,Cr:YSGG laser may be effective in decontamination of E. faecalis and may be regarded as a promising tool in the disinfection of dental implant surfaces.

REFERENCES


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