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The Bactericidal Effect Of Erbium, Chromium: Yttrium Scandium Gallium Garnet Laser On Contaminated Sand-Blasted, Large Grit, Acid-Etched Dental

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الخلاصة

الاهداف:تهدف الدراسة الى تقيم فعالية الليزر نوع (Erbium,Chromium:Yttrium Scandium Gallium Garnet)في الابادة البكتيرية لاسطح الغرسات السنية الملوثة والمعاملة بالسفع الرملي والخراطة الحامضية (sand-blasted, large grit, acid- etched))ولتحديد ضوابط القيم المتغيرة لجهاز الليزر والتي تزيل التلوث بفعالية من سطح الغرسة الملوثة كنموذج مختبري يماثل الغرسة المصابة بالتهاب ماحولها-peri) (implantitisوذلك قبل العلاج بالتنخيع العظمي.**الموا د وطرائق العمل:** استخدمت غرسات سنية بقطر ٣.٤ *وطول ١٠ملم بعد تلويثها ببكتيريا نوع Enterococcus faecalis ومن ثم تعريضها لليزر وبعد التعرض تم حساب اعداد المستعمرات البكتيرية لكل اسطح الغرسة .تعريضها لليزر تم بالاستعانة بجهاز الميللنك ومحرك الدوران.كل معايرالتعرض لليزر تم تثبيتها ما عدا مستوى طاقة متغيرحيث تم استخدام(٠.٢٥-٠.٥-٠.٧٥-١-١.٢٥-١.٥ واط) - الماء٢٠%- الهواء٤٠%- التردد٢٠ هيرتز-التباعد بين الهدف وراس الليزر نوع (MZ10)هو(٢)ملم مع زمن تعرض لليزر (٣٠) ثانية مع طور.H**النتائج**:تم الحصول على ابادة كاملة للبكتيريا عند مستوى طاقة (١.٥ واط)واظهر التحليل الاحصائي فوارق معنوية بين المجاميع عند مستوى معنوية ($P<0.05$) حيث اعتمدت المشاهدات على مستويات الطاقة المختلفة.**الاستنتاجات**:يمكن استخدام الليزر (Er,Cr:YSGG) بامان حسب الضوابط اعلاه لغرض تعقيم سطح الزرعة المصابة بالتهاب ماحول الغرسة وقبل العلاج بالتنخيع العظمي

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 groups at ($P<0.05$) were observed, depending on the used power. **Conclusions**: Er,Cr:YSGGlaser 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.

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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 surfaceis 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 techniquesis 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

Seventydental 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).

Figure (1) :Field of working area include laser with micro motor

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).

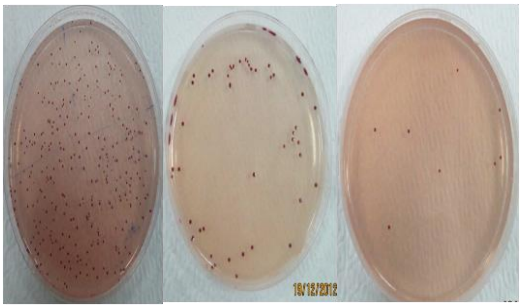
Figure(2)Position of fixture during laser exposure

Incubation of implant with bacteria

Culture media preparation Enterococcus faecalis agar media(HiMedia, India) was prepared by adding 42gmof 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 85C 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, Collage 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 4X107 CFU/ml .[18] 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 37c for18h 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, 1,1.25watt respectively

At the end of the incubation periods, the bacterialgrowth 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 isM-EnterococcusIndia 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.Thehand 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° 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)

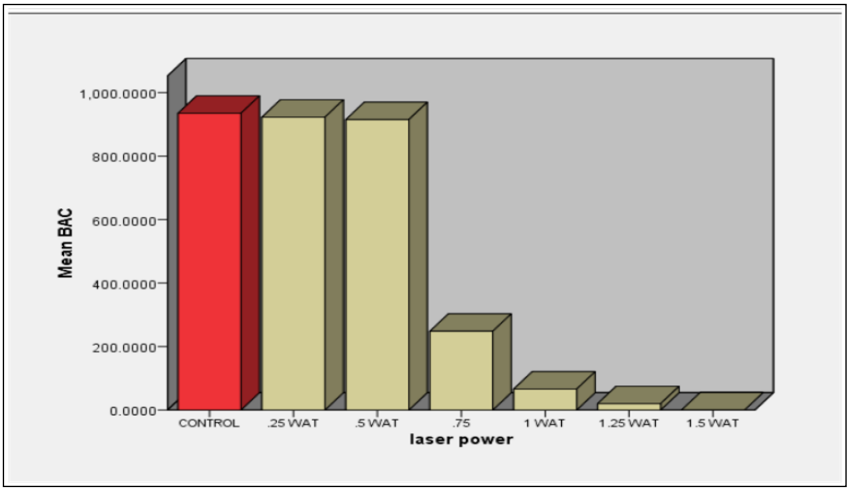
Bacteria	Sum of Squares	df	Mean Square	F	*p*-value
Between Groups	12501392.326	6	2083565.388	5901.192	.000
Within Groups	22243.748	63	353.075		
Total	12523636.074	69			

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

Group	**No.**	**Mean Bacteria.± SD**	**Duncan group*.**
1.5 WATT	10	.000000 ±0E-7	**A**
1.25 WATT	10	20.060000 ±2.4891766	**B**
1 WATT	10	66.020000 ±27.5233154	**C**
0.75WATT	10	248.060000 ±20.3373876	**D**
0.5 WATT	10	915.020000 ±15.1679340	**E**
0.25 WATT	10	922.660000e±25.5899373	**EF****
control	10	934.960000 ±20.2306258	**F**

*Means with different letter were astatically significant at($p\leq0.001$)
**No significant different between them.

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 0.25and0.5 watts.



Figure(5): Mean bacterial reduction in different power laser power.

DISCUSSION

In this study, E. faecalis(gram-positive facultative anaerobic microorganism)was chosen as the test microorganismbecause it is one of the most resistant microorganisms in the oral cavity[20, 21]. The utilizing of different types of lasers for the decontaminationof periodontal pockets, bone surfaces, may consider new field in peri-implantitis management. The decrease ofmicroorganisms by the laser action, although confirmedby multiple studies, has some aspect when used forthe treatments of peri-implant disease, as in many casesthe laser action may affect the implants titanium surface[22-25].So the type of laser and its parameter should always detect to avoid the negative changes that may effect on the process of osseointegration. The results in the present study showed that the group treated with1.5 watts for 30 second can decontaminate the rough implant surface according to the methodology that were used.

The findingpresented by Cheng et al. can demonstrated at 1Watt and 1.5 Watt, the Er,Cr:YSGG laserwas able to reduce E. faecalis by 77% and 96% respectively however the condition of hisstudy is different but it can give us the power that can be deal with bacteria.[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, especiallyat the lased margins with no microscopicevidence of inflammation or osteoclastic activity[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 [28].

Regarding to the effect of this laser on surface topography , the parameter that were used can be considered a 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 [29].

CONCLUSION

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

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