Evaluating Bacterial Adhesion and Decontamination of PDL Implants

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ABSTRACT

Background: The bacterial adhesion conditions on the surface of SLA implant was well documented. However, the interactions of bacterial adhesion and the laser treated implant, with micro to nano surface structure, were still undiscovered. In addition, the decontaminating methods for the treatment of peri-implantitis attracted much interest, especially for laser textured implant surface
This study is to comparatively evaluate the bacterial adhesion of Precision Dimension Laser (PDL)-treated implant and SLA implant. In addition, the different decontaminating methods including photodynamic therapy (aPDT) and Er:YAG laser / aPDT combination therapy on the PDL implant will also be evaluated to explore the unmet clinical application

Aims: This work is to comparatively study the bacterial adhesion of Precision Dimension Laser (PDL)-treated implant and SLA implant. In addition, the different decontaminating methods including photodynamic therapy (aPDT) and Er:YAG laser / aPDT combination therapy on the PDL implant will also be evaluated to explore the unmet clinical application

Materials and methods: The sandblasting, large-grit, and acid-etching (SLA)samples were used as the control groups, while PDL(Precision Dimension Laser)samples were used as experimental groups. Gram-negative bacteria Aa (A. actinomycetemcomitans) and Gram-positive bacteria Sm (S. mutans)were used to examine the bacterial adhesion. Morphologies of the two surfaces were observed before and after bacterial adhesion by scanning electron microscope. The eradication efficacy by MB-PDT (conc. 200-400 ug/ml) at 660 nm wavelength for 1 min treatment was also evaluated. Er:YAG laser was also used to eliminate the bacterial adhesion. Finally, the synergic combination of Er:YAG laser and MB-PDT was performed to understand the eradication efficacy against the bacterial adhesion.

Results: 1. Nano-complex surface architecture rather than Ra value close related to bacterial attachment to the titanium implant.
2. In 6 to 24 hours of bacterial culture, more amount of bacteria can be observed in PDL group. However, 48 hours later, there was no difference between 2 groups both in A.a. and S mutans.
3. Methylene blue-mediated aPDT or Er:YAG laser alone failed to completely eliminate bacteria.
4. The combination therapy of Er:YAG Laser and aPDT system can clean deeply and efficiently into microchannels for both SLA and PDL surface without altering the surface architecture, could be a useful cleaning method for peri-implantitis therapy especially for a nano microtextured surface .
Conclusions: Regarding the bacterial, A. actinomycetemcomitans, will cause the implantise, the amount of bacterial adhesion in 48 hours is no big difference between SLA implant and PDL (laser treated implant).
2. The combination of PDT and Er:YAG revealed a highly effective eradication for SLA treated implant and laser treated implant.
3. Further investigations, such as the use of various cleaning process and the multispecies biofilm model, are required prior to the clinical applications.

INTRODUCTION

The project is to comparatively study the bacterial adhesion of PDL(Precision Dimension Laser)-treated implant with SLA implant. In addition, photodynamic therapy(PDT) efficacy on the PDL-treated implant will also be evaluated to explore the unmet clinical application. Neither Er:YAG laser nor Methylene Blue(MB)-PDT did not achieve to completely eradicate the bacterial adhesion. In contrast, the synergic combination of Er:YAG laser and MB-PDT could completely eliminate the bacterial colonies adherent to the PDL- and SLA-treated implant surfaces.

METHODS AND MATERIALS

Materials and methods:
The sandblasting, large-grit, and acid-etching (SLA)samples were used as the control groups, while PDL(Precision Dimension Laser)samples were used as experimental groups. Gram-negative bacteria Aa (A. actinomycetemcomitans) and Gram-positive bacteria Sm (S. mutans)were used to examine the bacterial adhesion. Morphologies of the two surfaces were observed before and after bacterial adhesion by scanning electron microscope. The eradication efficacy by MB-PDT (conc. 200-400 ug/ml) at 660 nm wavelength for 1 min treatment was also evaluated. Er:YAG laser was also used to eliminate the bacterial adhesion. Finally, the synergic combination of Er:YAG laser and MB-PDT was performed to understand the eradication efficacy against the bacterial adhesion.

RESULTS AND DISCUSSION

Bacterial viability of *A. a.*and *S. m.* seeding on the PDL and SLA implant surfaces using alamar Blue assay. After 12 hours of culture, There was no difference of bacterial counts in SLA and PDL groups. (Fig. 1)
The changes in the antimicrobial effectiveness of methylene blue (MB) (200, 300, and 400 μg/mL) -mediated PDT against the reduction of *A. a.* and *S. m.* seeded on PDL and SLA implant surfaces for 24 and 48 h. The best reduction result was in SLA / 24 hours group. (Fig. 2) The other 3 groups (PDL/24, PDL/48, SLA/48) showed no difference.
The antimicrobial effectiveness of Er:YAG, methylene blue-mediated PDT, and the combination of Er:YAG + MB-mediated PDT against the reduction of *A. a.* and *S. m.* seeded on PDL and SLA implant surfaces for 24 h. The results indicated that the combination therapy (Er:YAG Laser + MB-PDT) showed high percentage of bacterial reduction in all groups. (Fig. 3)
SEM of the PDL surfaces with *A. actinomycetemcomitans and S. mutans* adhesion for 24 h after PDT with different MB concentrations for 1 min. Arrows show the bacterial species.

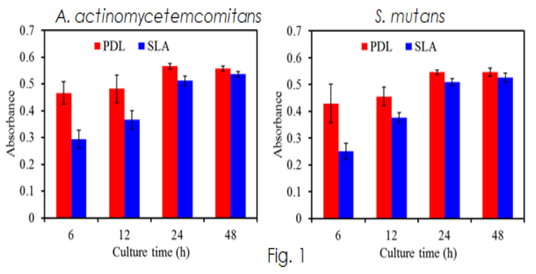

Fig. 1

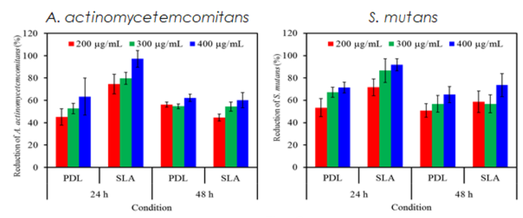

Fig. 2

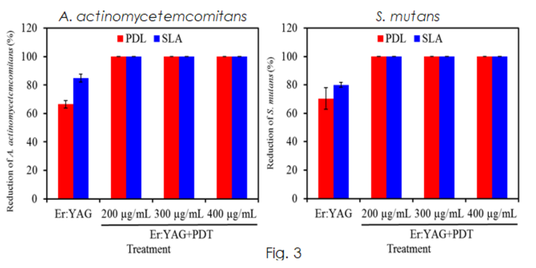

Fig. 3

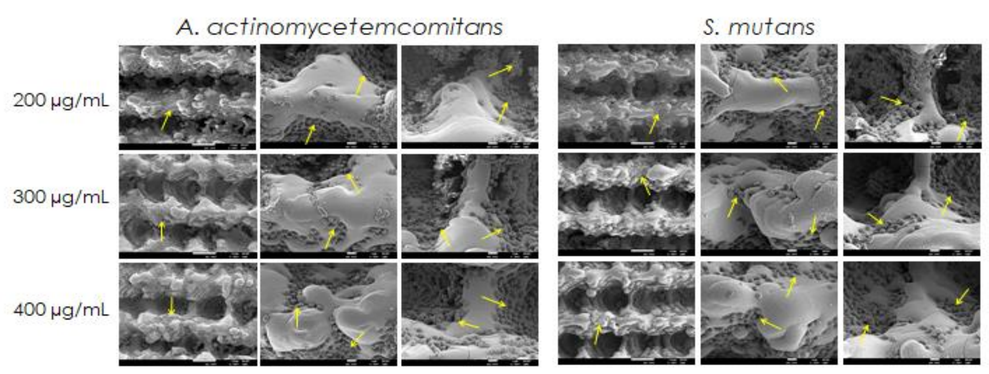

Fig. 4

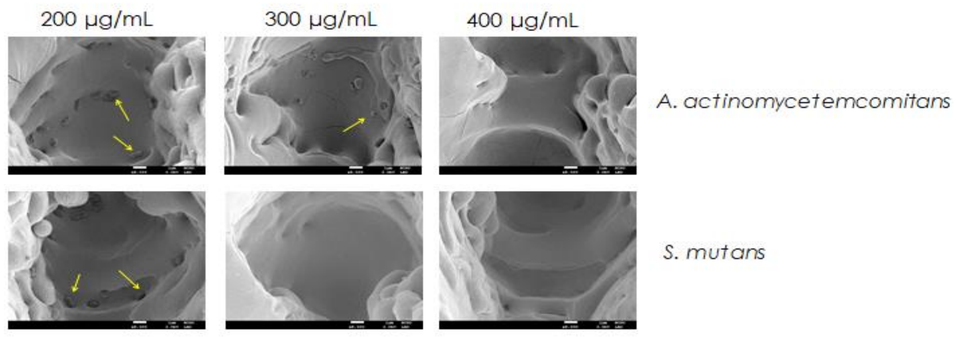

Fig. 5 SEM of the PDL surfaces with *A. a. and S. m.* adhesion for 24 h after Er:YAG + MB-mediated PDT.

CONCLUSIONS

1. PDL promoted the bacterial adhesion the same as SLA implant surfaces.
2. Methylene blue-mediated PDT failed to completely eliminate bacteria.
3. The combination of PDT and Er:YAG revealed an effective eradication.
4. Further investigations, such as the use of various cleaning process and the multispecies biofilm model, are required prior to the clinical applications

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