The efficacy of antimicrobial photodynamic therapy and light-activated disinfection on zirconia implants: In vitro study

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Background and Aim

Peri-implantitis is an disease affecting the soft and hard tissue around implants, resulting in the loss of supporting bone. With the increasing popularity of zirconia dental implants, the need for effective and predictable decontamination protocols of the implant surfaces is becoming more and more important. Many in vitro, animal, and clinical studies have already shown the non-invasive PDT to be successful and safe as an adjunct therapeutic protocol for titanium peri-implantitis. The aim of this study was to evaluate the effect of antimicrobial photodynamic therapy and light-activated disinfection on contaminated zirconia dental implants and investigate if the PDT and LAD cause implant surface alterations.

Methods and Materials

Seventy two zirconia dental implants were contaminated with a bacterial suspension prepared from three different bacteria: *Prevotella intermedia*, *Aggregatibacter actinomycetemcomitans*, and *Porphyromonas gingivalis* (Figure 1.). After contamination, the implants were randomly divided into four test groups (n=12) according to the decontamination protocol: Group 1 (PDT1): PDT (660 nm, 100 mW) with toluidine blue; Group 2 (PDT2): PDT (660 nm, 100 mW) with phenothiazine chloride dye (Figure 2); Group 3 (LAD): light emitting diode (LED) with toluidine blue; Group 4 (TB): toluidine blue without the application of light (Table 1.). In addition two control groups were used: the positive control (PC) group were treated with a 0.2% chlorhexidine-based solution, and implants assigned to the negative control (NC) group, did not receive any treatment. After treatment protocol the implants were put into Eppendorf tubes containing PBS, they were vortexed and 0.1 ml was taken out of each tube and placed in Brucella agar plates. After 72h colony forming units (CFUs) were counted. The implants were analyzed using scanning electron microscope (SEM) to evaluate the possible surface alterations due to the PDT or the LAD protocols.

Figure 1. Zirconia dental implant immersed in bacterial suspension.
Figure 2. Zirconia dental implant placed on a rotational electric motor (10rpm) and treated for 60 seconds with PDT2.

Table 1. Parameters for PDT1, PDT2, and LAD

	PDT1	PDT2	LAD
Light Source:	Diode Laser (LaserHf)	Diode Laser (Helbo)	Light emitting diode
Wavelength:	660 nm	660 nm	660 nm
Photosensitizer:	Toluidine blue based dye	Phenothiazine chloride dye	Toluidine blue dye
Power Output:	100 mW	100 mW	200 mW
Power Density:	124.3 W/cm ²	35.37W/cm ²	0.71 W/cm ²
Light source diameter	320 μm	0.06 cm	0.6cm
Working Mode:	Continuous	Continuous	Continuous
Irradiation time:	60 s	60 s	60 s

Results

All study groups reduced the number of CFUs significantly compared with the NC (p<0.05) with more than 99% bacterial reduction. PDT1, the PDT2 and the LAD groups had the largest bacterial reduction, and were more efficient compared with the TB group (p<0.05)..

Figure 3. Brucella Agar plate with visible bacterial colonies (negative control group).
Figure 4. Brucella Agar plate with little visible bacterial colonies.

SEM analysis did not reveal any alterations of the implant surface after the treatment procedures, compared to a sterile unopened zirconia implant (Figure 5-8).

Figure 5-8. SEM image of a sterile unopened zirconia implant (Upper left); SEM image of a zirconia implant treated with PDT1 (Upper right); SEM image of a zirconia implant treated with PDT2 (Lower left); SEM image of a zirconia implant treated with LAD (lower right).

Conclusion

Both PDT protocols and the LAD showed high and equal effectiveness in decontamination of zirconia dental implants. Further clinical studies are needed in order to establish a clear and effective decontamination protocol of the zirconia implant surfaces using PDT or LAD

References

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