Radiographic evaluations on the osseointegration of photo-catalytically modified dental implants in a murine model

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Abstract

Osseointegration is defined as: a direct structural and functional connection between ordered, living bone and the surface of a load-carrying implant, without intervening soft tissue, is critical for implant stability and considered a prerequisite for long-term clinical success of endosseous dental implants. Many types of implant surface modification are available nowadays to enhance osseointegration. Light-activated TiO₂ surface is one of the surface treatment of titanium. The purpose of the present study was to investigate the effects of the implants, which were coated with the light responsive photocatalytic material, on osseointegration. Maxillary first molars of 6 male C57BL/6NCrSlc mice were extracted bilaterally. Eight weeks after the extraction, two implants were placed in both sides of the maxilla. Photocatalyst implant was placed on the right side (test group) and conventional pure titanium implant was on the left side (control group). After 3, 4 and 6 weeks of implant placement, the animals were sacrificed. The implants and the surrounding tissues were analyzed radiographically. All implants were osseointegrated into bone. But there were no statistically significant differences.

Background and Aim

Currently oral rehabilitation with dental implants is effective and predictable. Although implant treatment is widely spread, “peri-implantitis” is a rapidly emerging problem in implant dentistry. Various surface modifications of the implants promote osseointegration; however, they are vulnerable to infection compared to the classical machined surface. Interestingly, the photocatalytic material of specific TiO₂, which can be activated under visible light (~400nm) producing active oxygen, has been developed. This material could be potentially useful to prevent and/or treat peri-implantitis if applied to the implant surface. The purpose of the present study was to investigate the effects of the implants, which were coated with the light responsive photocatalytic material, on osseointegration.

Methods and Materials

Animals: Six male (4-week-old) C57BL/6NCrSlc mice (Sankyo Labo Service Corp., Inc., Tokyo, Japan) were used in this study. Implants: Twelve custom-made pure titanium machined screw type implants (diameter=0.8mm, length=1.5mm, Matsumoto Industry Co., Ltd) were prepared. Half of the implants were coated with visible light responsive photocatalyst paint consisting of specific TiO₂ and sintered. The animals were anesthetized with intraperitoneal administration of ketamine (100mg/kg) and xylazine (5mg/kg). Stereo microscope was used in this experimental surgery. Maxillary first molars of 6 male C57BL/6NCrSlc mice were extracted bilaterally using Terumo needle 27G x 1” (Terumo Medical Corp., Tokyo, Japan). Eight weeks after the extraction, two implants were placed in both sides of the maxilla without raising flap. First, soft tissue was punched off with needle and then approximately 1.1mm deep osteotomy sites were created with K-files from K25 (diameter=0.25mm) to K80 (diameter=0.8mm) with gentle manual rotations. Then, implants were screwed into the prepared osteotomy sites by using custom driver (Matsumoto Industry Co., Ltd). Photocatalyst implant was placed on the right side (test group) and conventional pure titanium implant was on the left side (control group). After 3, 4 and 6 weeks of implant placement, the animals were sacrificed. The implants and the surrounding tissues were analyzed radiographically with Micro CT (InspeXio; Shimadzu Science East Corp., Tokyo, Japan). Volumetric data were reconstructed by using 3D software (Tri/3D-Bon, RATOC system Engineering Co. Ltd, Tokyo, Japan).

Results

Clinically, the implants were stable in the bone. According to Micro CT results, all the implants were well integrated to the bone. In all time points, both mesial and distal aspects of peri-implant bone level of photocatalyst implants showed higher osseointegration value than control. But there were no statistically significant differences between test and control implants according to micro-CT data.

Conclusions

The present study demonstrated that the photocatalyst implant can integrate to the bone at 3-week. The difference of bone-implant contact between the test and the control groups was not clear, which should be clarified on histological sections. In the limited results of this study, preventive effects of this new surface in peri-implantitis have been expected, which requires further animal studies.

References

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