ORAL PECONSTRUCTION FOUNDATION

An in vivo and in vitro investigation on a novel silica-based antibacterial coating for titanium implant

Wei Hongbo,Wang Jia,Li Dehua

State Key laboratory of Military stomatology, National clinical research center for Oral Diseases, Department of Oral Implants, school of stomatology, The Fourth Military Medical University, China

Introduction and Purpose: Although titanium implant prosthesis has become the best choice for the missing teeth, peri-implantitis still occurs at a significant rate. This unwanted complication occurs due to adhesion of bacteria and subsequent bioimformation. To solve this problem, our team has developed a novel self-decomposible silica nanoparticle-based coating on micro arc-oxidized titanium implant.

Materials and methods: In this study, silica-gentamycin (SG) nanoparticles were successfully fabricated using an innovative one-pot solution. The nanoparticles were incorporated within a gelatin matrix and cross-linked on micro arc-oxidized titanium. To characterize the SG nanoparticles, their particle size, zeta potential, surface morphology, in vitro drug release, and decomposition process were sequentially evaluated. The antibacterial properties against the gram-positive Staphylococcus aureus, including bacterial viability, antibacterial rate, and bacteria morphology, were analyzed using SG-loaded titanium specimens. Any possible influence of released gentamycin on the viability of human fibroblasts, which are the main component of soft tissues, was investigated. Titanium specimens with antibacterial coating were implanted into rat tibia to evaluate the formation ability of a stable skin-implant seal. The animals were killed for the examinations of gross, scanning electron microscope(SEM), micro CT, and histological studies 12 weeks of operation.

Results: SG nanoparticles from the antibacterial titanium coating continuously released gentamycin and inhibited S. aureus growth. In vitro investigation showed that the obtained nanodelivery system has good biocompatibility. Results also indicated that the designed coating titanium screws are more suitable for the application of implant which penetrates the skin when compared to the control groups.

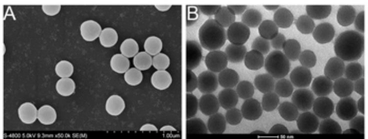
Figure1 (A) SEM images of sg nanoparticles, (B) TEM images of sg nanoparticles.

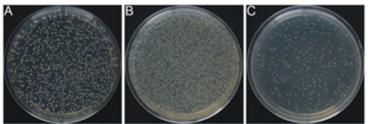
Figure4 Bacteria colonies cultivated on Mueller – hinton agar plates from (A) S-Ti, (B) MAO-Ti, and (C) SG-Ti groups

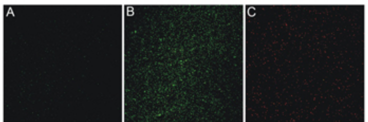
Figure5 Staphylococcus aureus adherence on the (A) s-Ti, (B) MaO-Ti, and (C) SG-Ti specimens as observed by uorescence microscopy.

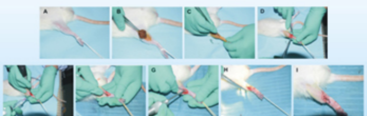
Figure8 Process of implantation in vivo

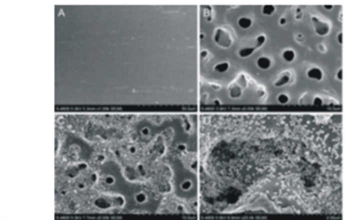
Figure2 SEM images of (A) smooth titanium surface, (B) titanium surface after microarc-oxidized treatment, (C) titanium surface with antibacterial coating under low magni cation, and (inset) under high magni catio

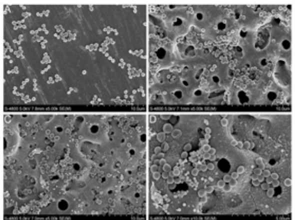
Figure6 SEM images of Staphylococcus aureus colonized on (A) s-Ti, (B) MaO-Ti, and (C) SG-Ti under low magni cation and (D) bacteria with deformed membranes under higher magni cation.

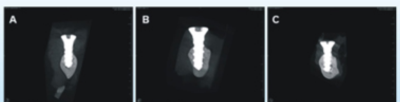
Figure9 Micro CT images of (A) S-Implant, (B) MAO-Implant, and (C) SG-Implant after 12 weeks

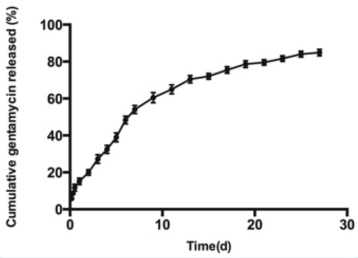

Figure3 Release pro le for SG nanoparticles soaked in PBS over 25 days

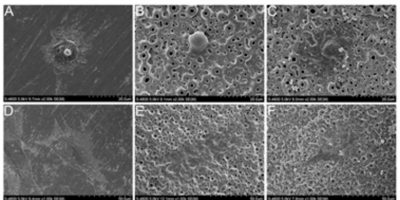
Figure7 Representative SEM imaged of human broblasts spread on (A) S-Ti after 2 hours, (B) MAO-Ti after 2 hours, (C) SG-Ti after 2 hours, (D) S-Ti after 24 hours, (E) MAO-Ti after 24 hours, and (F) SG-Ti after 24 hours.

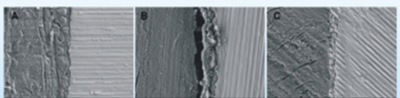
Figure10 SEM images of (A) S-Implant section, (B) MAO-Implant section, and (C) SG-Implant section after 12 weeks

Conclusions: Therefore, this design can be further investigated as a method to prevent infection around implants.

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