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Jiahe Li
Sichuan University, China

Title: Glucose-gated Polyetheretherketone Implants for Enzymatic Gas Therapy to Boost Infectious Diabetic Osseointegration

Abstract:

The hyperglycemic micromilieu surrounding implants in diabetic patients leads to high failure rate of implantation and implant-associated infection. Carbon monoxide (CO) has been reported to combat infections; however, its on-demand liberation and the elucidation of the underlying antibacterial mechanism remain challenging. To combat the deleterious diabetic micromilieu, we propose a glucose-gated enzymatic gas therapy.

To address this issue, we develop a multipurpose orthopedic implant comprising polyetheretherketone, glucose oxidase (GOx), and manganese carbonyl (MnCO), serving as a glucose-gated enzymatic gas therapy for infectious diabetic osseointegration. CO generation can be induced by H2O2 produced during GOx-mediated glucose oxidation, which offers a glucose- actuated switch for GOx. The GOx acts as a glucose-actuated gate responsive to hyperglycemia, thereby delivering CO in situ triggered by the GOx-driven Fenton-like reaction of MnCO.

A multifunctional orthopedic implant was engineered in which the glucose-actuated gate GOx facilitated the on-demand delivery of CO and Mn2+ and the hyperglycemic micromilieu was remodeled via glucose consumption. The engineered implant demonstrated exceptional controllable disinfection properties and reinforced osteogenicity in vitro. The released CO considerably prevents bacterial multiplication by penetrating the membrane, binding to cytochrome bo3, and interfering with the respiratory chain in vitro. Furthermore, the engineered implant displays desired antibacterial properties and enhances osseointegration in vivo. Collectively, the orthopedic implant is capable of delivering glucose-gated enzymatic gas therapy, promising for treating infectious diabetic bone defects.

Altogether, our glucose-gated implant based on an enzymatic gas strategy demonstrated impressive antibacterial properties and osteogenicity in a diabetic infectious model, and we struggle to elucidate its underlying antibacterial mechanism. This work is anticipated to provide an avenue for treating implant-related infectious diabetic bone defects.

Jiahe Li

Sichuan University, China

Biography

Dr. Jiahe Li received his DDS degree from West China College of Stomatology, Sichuan University in China, and then completed a 3-year post-graduate residency and accomplished his master's degree of Endodontics in West China College of Stomatology, China. Dr. Jiahe Li maintains membership of multiple organization such as the American Association of Periodontology, International Team for Implantology, Academy of Osseointegration. He has published research articles in oral biomaterials. He has given several oral presentations on scientific research at the AO conference and the IADR Conference.