Porous Silicon: Synthetic Mineral Bioresorbable Scaffold for Orthopedic Tissue Engineering

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ABSTRACT

This research focuses on porous silicon (PSi) microparticles as a scaffold for bone tissue engineering, that facilitates cell adhesion and osteodifferentiation, and provides clues to clinically enhance bone regeneration. In medicine, conventional bone substitutes provide limited efficacy; and there is a need for more versatile material that facilitates each and every bone regeneration scenario. An ideal orthopedic tissue engineering material should be biocompatible, bioresorbable, bioactive, favorable for cell adhesion, osteoconductive as well as osteoinductive and widely available. Fortunately, porous silicon has all these qualities of absolute interest.

Dental pulp stem cells (DPSCs) are mesenchymal stem cells with low immunogenicity and accessibility. Our experiments suggest that PSi microparticles support DPSCs growth and osteodifferentiation and offers promising scope for bone regeneration.

A vital aspect for *in vivo* applications is characterizing the dissolution of PSi, to adapt biomaterial resorption to bone formation. The real-time dissolution kinetics is mapped using several qualitative and quantitative techniques. Successful evidence of bone-like matrix formation and complete dissolution demonstrate the efficacy of this scaffold. We found that PSi resorption with silicic acid release appears immediately after implantation, and, particles oxidation interferes with dissolution; such changes are highlighted by spectroscopic studies.

Positive evidence from *in vitro* calcium phosphate deposition followed by enhanced mineral density, *in vivo;* establishes the efficacy of PSi & DPSCs scaffold compared to other orthopedic materials. This scaffold has the potential to serve for the bone regeneration for dental implants and alveolar ridge rehabilitation as well as for large bony defect where the metallic prosthesis is the only choice of treatment.

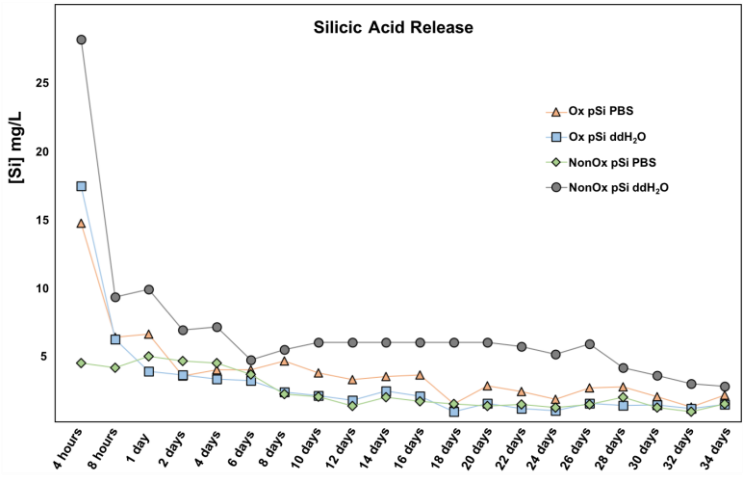

Figure 1: In vitro kinetics of porous silicon dissolution with silicic acid release.

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