

## **Development of a Novel Bioimplant with Both Infection Resistance and Osteogenic Potential Using Iodine-Supported Porous Titanium and Adipose-Derived Stem Cells**

Katsuhiko Hayashi, Shinji Miwa, Yuta Taniguchi, Hiroataka Yonezawa, Sei Morinaga, Yohei Asano, Satoru Demura

**INTRODUCTION:** The increasing number of orthopedic surgeries in aging societies has led to a rise in implant-associated infections. These infections often require multiple surgeries and sometimes persist even after reimplantation. To address this challenge, we aimed to develop a novel implant with both high infection resistance and osteogenic potential. Our previous work has revealed that iodine-supported titanium possesses both antibacterial activity and bone affinity. By combining this material with adipose-derived stem cells (ADSCs), we attempted to create a hybrid bioimplant capable of promoting bone regeneration while resisting infection.

**METHODS:** We used commercially pure titanium, Ti-6Al-4V alloy, and a porous titanium alloy (Tritanium®, Stryker) as implant substrates. These materials were anodized (15V, 1 min), acid-treated (10 min), and immersed in an iodine solution for 60 min. Iodine loading was quantified via X-ray fluorescence analysis (XRF). ADSCs were isolated from rabbit subcutaneous adipose tissue using collagenase digestion, cultured in DMEM with 10% FBS, and used at passages 2–4. Cell viability was assessed by WST assay, and adhesion patterns were evaluated with crystal violet staining and scanning electron microscopy (SEM). For osteogenic evaluation, ADSC spheroids were placed on the implants and cultured in osteogenic medium. Glucose consumption, LDH release, and ALP mRNA expression (via qPCR) were measured. A spheroid-based coating method using polyethylene terephthalate (PET) mesh was applied to uniformly distribute spheroids across the implant surface. Histological evaluation was performed after methyl methacrylate embedding and polishing.

**RESULTS:** Iodine loading was successful: 12.5  $\mu\text{g}/\text{cm}^2$  on pure titanium, 13.6  $\mu\text{g}/\text{cm}^2$  on Ti-6Al-4V, and up to 95.2  $\mu\text{g}/\text{cm}^2$  on porous Tritanium. ADSCs showed >90% viability compared to plastic controls, with good adherence and proliferation into the inner pores of Tritanium over 7 days. Glucose consumption peaked by day 5 and decreased thereafter. ALP mRNA expression confirmed osteogenic differentiation on iodine-supported implants. PET mesh compression enabled uniform spheroid distribution, with histological sections confirming surface coverage and partial penetration into pores. Further improvements are needed for deeper infiltration. A collagen co-culture method enabled full 3D coverage of the implant, achieving uniform cell adhesion across all surfaces.

**DISCUSSION AND CONCLUSION:** We successfully developed a bioimplant with dual functions: infection resistance via iodine support and osteogenic capability via ADSC integration. The PET-assisted spheroid distribution and collagen-coating methods were effective in achieving uniform cell coverage, critical for future in vivo application. This hybrid implant represents a promising candidate for use in orthopedic surgery where both infection control and bone regeneration are essential. Further in vivo studies are warranted to confirm efficacy and safety.