Dense Titanium Implants Embedded with Growth Factors

Hyun-Do Jung, Eun-Jung Lee, Hyoun-Ee Kim
Department of Materials Science and Engineering, Seoul National University, Seoul, Korea

Statement of Purpose:

Titanium (Ti) and its alloys are used extensively for orthopedic and dental implants, owing to their good mechanical properties, chemical stability, and biocompatibility [1]. Recently, osteoinductivity of biomedical implants was improved significantly by incorporating with growth factors, such as bone morphogenetic proteins (BMPs). Since these growth factors can promote cell proliferation and differentiation, they are effective in supporting tissue regeneration and healing [2]. However, growth factors deposited on the implant surface are generally released with a rapid burst [3]. Therefore, the osteogenic effect is minimal. In this study, we fabricated BMPs-embedded titanium implants using new techniques and improved the potential for embedment of growth factors.

Methods:

To load growth factor in dense Ti, porous Ti discs (16.5 mmΦ X 10 mm, porosity: 66%, pore size: 300 μm) were soaked in BMP-2 solution(10μg/ml) in a vacuum, and then air-dried. After drying, coated porous Ti discs were pressed by uniaxial press. The cell attachment behavior was evaluated by the visual observation of cells using CLSM. To verify the ability of embedment, green fluorescent protein (GFP) (240μg/ml) was embedded in Ti by same method. Release of GFP from the dense Ti was examined in phosphate buffered saline solution (pH 7.4) at 37°C by using the CLSM.

Results:

Fig. 1(A) shows optical image of the Ti before and after pressing the porous specimen. After pressing, the Ti was well-densified without any noticeable defects, such as cracking or large voids. The cross-sections of the Ti before and after pressing were shown in Fig. 1(B-D). It should be noted that the porosity decreased as pressure increased and that the Ti was almost densified when the pressure reached to 1500MPa as shown in Fig. 1(D). When the MC3T3-E1 cells were cultured for 1h, they were attached better on the dense Ti embedded with BMP-2 (Fig. 2(B)) than on bare Ti (Fig. 2(A)). The surface of dense Ti embedded with GFP was observed up to 110days (Fig. 3). In bare Ti, the fluorescence became dark because surface coated GFP was released quickly. On the other hand, the GFP was continuously released from the dense specimens for up to 110 days (Fig. 3(B)).

Conclusions:

We demonstrated that the possibility of fabricating dense metallic implants embedded with growth factors. The GFP embedded in the Ti was continuously released for up to 110days.

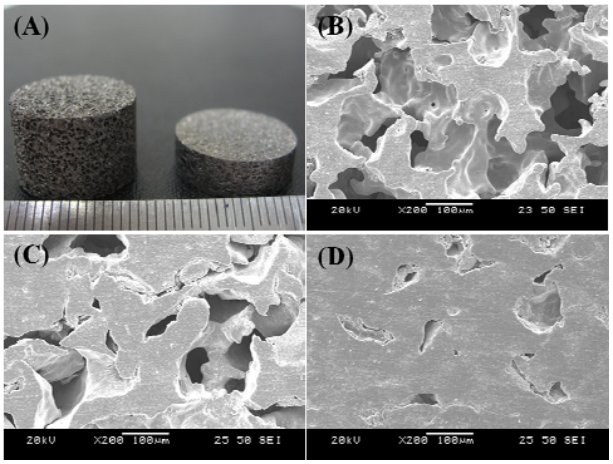

Fig 1. Optical image of (A) porous Ti(left) and dense Ti(right) and SEM images of cross-section after densification (B) porous Ti (C) 750MPa (D) 1500MPa

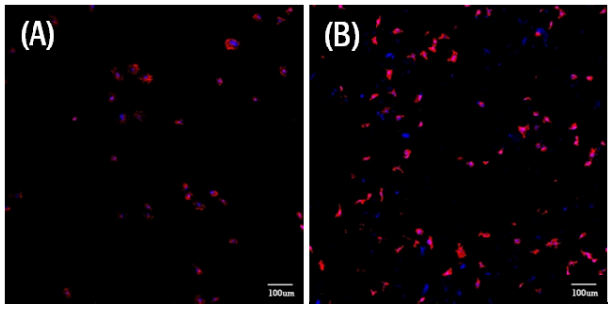

Fig 2. CLSM images of attached MC3T3-E1 cells after 1h culture on prepared Ti surface (A) bare Ti (B) dense Ti

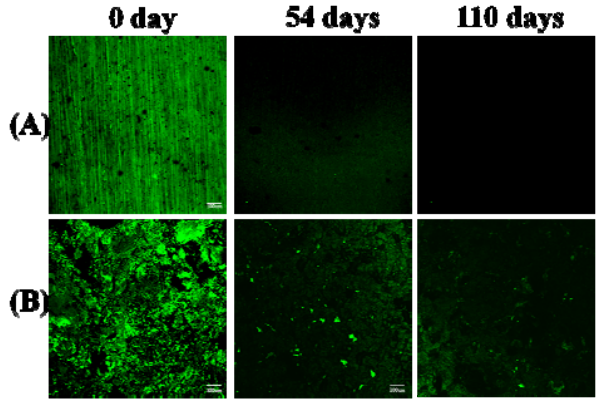

Fig 3. CLSM images of GFP on the titanium surface after release (A) bare Ti (B) dense Ti

References:

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2. Xiao YT et al. Biochemical and Biophysical Research Communications 2007; **362**; 550-553
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