

DEVELOPMENT OF BIOACTIVE ZIRCONIUM ALLOY BY INCORPORATION OF APATITE NUCLEI

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ABSTRACT

Micropores were formed on the surface of zirconium alloy plates by immersing in sulfuric acid. In order to provide bioactivity to them, Apatite Nuclei (AN) was precipitated in the pores. The bioactivity of the zirconium alloy plates was evaluated by using SBF. After immersing in SBF for 1 day, apatite formation was observed on the whole surface of the zirconium alloy plate. From this result, bioactivity was given to the micropores-formed zirconium alloy within 1 day by the function of AN.

Keywords: Zirconium alloy, Bioactivity, Apatite Nucleus (AN), Implant material

INTRODUCTION

Zirconium alloy has high corrosion resistance and its Young's modulus is lower than that of titanium (Ti) metal. Moreover, zirconium alloy has lower magnetic susceptibility than Ti metal, so it is hardly affected by a magnetic apparatus such as magnetic resonance imaging (MRI). Although this metal is biocompatible, their bioactivity is too poor to bond to living bones. If they can acquire high bioactivity, range of its application will be largely extended.

When both pH and temperature of a simulated body fluid (SBF) [1-3] are raised properly, fine particles of calcium phosphate are precipitated. In our previous studies, we found that the fine particles were very active for forming apatite in SBF or body fluid and named the fine particles Apatite Nuclei (AN) [4,5]. In our previous study, high bioactivity was attained to polyetheretherketone (PEEK), titanium alloy and Zr by the function of the AN [6-8]. By precipitating AN on these samples and immersing them in SBF, we succeeded in forming hydroxyapatite on the whole surface of these samples. In this study, we formed micropores on zirconium alloy by sulfuric acid treatment and precipitated AN inside of the pores. Bioactivity was given to zirconium alloy by the function of AN.

MATERIALS and METHODS

Preparation of SBF

SBF was prepared by dissolving reagent-grade NaCl, $NaHCO_3$, KCl, $K_2HPO_4 \cdot 3H_2O$, $MgCl_2 \cdot 6H_2O$, $CaCl_2$ and Na_2SO_4 in distilled water with the composition as shown in Table 1 and buffered at pH 7.40 with tris(hydroxymethyl)aminomethane ($(CH_2OH)_3CNH_2$) at 36.5 °C.

Preparation of reaction solution (m-SBF)

An aqueous solution was prepared by dissolving 0.228 mg $K_2HPO_4 \cdot 3H_2O$, 0.305 mg $MgCl_2 \cdot 6H_2O$, 0.278 mg $CaCl_2$ and 35 ml 1 M-HCl in distilled water. Then, the volume of the solution was measured up to 1.0 L with distilled water, and the pH was adjusted to 8.20 with $(CH_2OH)_3CNH_2$ at 25 °C. This solution is denoted as

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