R-3. Characterization of a Novel Calcium-incorporated Titanium Surface

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Background

Numerous approaches have been tried in order to improve clinical results of endosseous implant in poor local bone conditions and to shorten healing period. One of the strategies used to improve osseointegration is to make the bioinert surfaces of metallic implants bioactive, thereby favoring bone-tissue reactions at the interface.

Recently, many studies have been demonstrated the advantages of titanium implants incorporating calclium ions(Ca) in enhancing osseointegration. Ca-deposited titanium implants achieved biochemical bone bonding in an animal study. Several studies have reported that an increased Ca composition in the outer oxide layer affected cell adhesion by increasing protein adsorption onto Ti surfaces at physiologic pH. It was reported that calcium titanate(CaTiO3) promoted osteoblast adhesion, and suggested CaTiO3 as a strong candidate for increasing osseointegration.

In this study, a novel nanostructured Ca coating on Ti substrate was produced and the surface characteristics were investigated and the apatite precipitation on Ti surface was evaluated.

Materials & Methods

Commercially pure Ti(ASTM Grade 2) in rectangular form(10×10×1.0㎜) were used. To investigate the effect of Ca-coating method on original microarchitecture, two different types of pretreatment were performed as follows: 1. wet abraded to 1200-grits using SiC abrasive paper and passivated in nitric acid according to ASTM specification F-86(machined); 2. blasted with hydroxyapatite particles (MegaGen, Kyungsan, Korea) and passivated(blasted). The pretreated Ti samples were chemically treated in Ca-containing solution. After treatment, Ti plates were ultrasonically cleaned in deionized water for 10 min and air-dried.

To evaluate apatite-forming ability, Ti samples were vertically immersed in HBSS with pH 7.4 at 37C. Surface structure were analyzed by scanning electron microscopy(SEM; S-4200, Hitachi, Tokyo, Japan), thin-film X-ray diffractometry(TF-

XRD; X'Pert-APD, Philips, Netherland), depth profiles in Auger electron spectroscopy(AES-depth profile; PHI 680, Auger Nanoprobe, Physical Electronics, USA), and X-ray photoelectron spectrometry(XPS; MT 500/1, VG Microtech Inc., UK).

Results & Discussion

After surface treatment, Ti samples showed crystalline CaTiO3 structure in the XRD patterns, and the samples showed nanostructured surface while preserving original micron-scale topography produced by pretreatment in SEM observation. XPS spectra showed the presence of Ca elements and they were gradually incorporated throughout the Ti oxide layer in AES-depth profiles. Thick apatite deposition was observed on the surfaces of treated Ti samples after they were soaked in HBSS.

The results of this study indicated that this Ca coating method may be used as an effective approach to providing bioactivity to Ti implant with microroughened surfaces which is related to biomechanical interlocking.