Enhancement of biocompatibility on bioactive titanium surface by low-temperature plasma treatment

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Abstract

The surface of implantable biomaterials directly contacts the host tissue and is critical in determining biocompatibility. To improve implant integration, interfacial reactions must be controlled to minimize nonspecific adsorption of proteins, and tissue-healing phenomena can be controlled. The purpose of this study was to develop a new method of functionalizing titanium surfaces by plasma treatment. The covalent immobilization of bioactive organic molecules and the bioactivities in vitro were assessed by transmission electron microscopy (TEM), atomic force spectroscopy (AFM), X-ray photoelectron spectroscopy (XPS), scanning electron microscopy (SEM), and 3-(4,5-dimethylthiazole-2-yl)-2,5-diphenyltetrazolium bromide (MTT) assay as indices of cellular cytotoxicity. Argon plasma removed all of the adsorbed contaminants and impurities. Plasma-cleaned titanium surfaces showed better bioactive performances than untreated titanium surfaces. The analytical results reveal that plasma-cleaned titanium surfaces provide a clean and reproducible starting condition for further plasma treatments to create well-controlled surface layers. Allylamine was ionized by plasma treatment, and acted as a medium to link albumin. Cells demonstrated a good spread, and a wide attachment was attained on the Albu-Ti plate. Cell attachment and growth were shown to be influenced by the surface properties. The plasma treatment process plays an important role in facilitating tissue healing. This process not only provides a clean titanium surface, but also leads to surface amination on plasma-treated titanium surfaces. Surface cleaning by ion bombardment and surface modification by plasma polymerization are believed to remove contamination on titanium surfaces and thus promote tissue healing.