



Improvement of osseointegration efficacy of titanium implant through plasma surface treatment

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Abstract

A novel plasma treatment source for generating cylindrical plasma on the surface of titanium dental implants is developed herein. Using the titanium implant as an electrode and the packaging wall as a dielectric barrier, a dielectric barrier discharge (DBD) plasma was generated, allowing the implant to remain sterile. Numerical and experimental investigations were conducted to determine the optimal discharge conditions for eliminating hydrocarbon impurities, which are known to degrade the bioactivity of the implant. XPS measurement confirmed that plasma treatment reduced the amount of carbon impurities on the implant surface by approximately 60%. Additionally, in vitro experiments demonstrated that the surface treatment significantly improved cell adhesion, proliferation, and differentiation. Collectively, we proposed a plasma treatment source for dental implants that successfully removes carbon impurities and facilitate the osseointegration of SLA implants.

Keywords Dielectric barrier discharge · Hydrocarbon · Titanium implant · Osseointegration · Surface treatment

1 Introduction

Dental implants are generally used as artificial tooth roots to support prosthetic suprastructures ranging from single-crown to fixed and removable prostheses. Long-term and stable fixation are the most essential requirements for successful implantation; therefore, osseointegration is

considered a critical implant fixation process [1]. The most commonly used implant material is titanium or titanium alloy, which is a gold standard for oral implant applications owing to its superior biocompatibility and ability to achieve osseointegration [2, 3]. Given that dental implants are in close and direct contact with bone tissues, the surface properties of titanium dental implants are the most important factors for effective osseointegration and long-term clinical success [4]. Rough surfaces are typically believed to be more crucial for osseointegration than smooth surfaces. Consequently, the topography and roughness of implant surfaces adjacent to bone tissues have continuously been improved to increase the long-term success rate [4–11]. Various surface treatment technologies, such as grit-blasting, acid-etching by mineral acids, and electrochemical anodic oxidation, have been developed to modify the surface roughness [12–14]. Recently, implants sandblasted with large grit followed by acid-etching (SLA) have become the global standard for enhancing surface roughness and facilitating osseointegration [6]. SLA implants have good clinical performance immediately after production, but surface aging owing to carbon contamination is inevitable because the implants are sterilized and exposed to the ambient air before being utilized in clinical practice. Furthermore, these

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