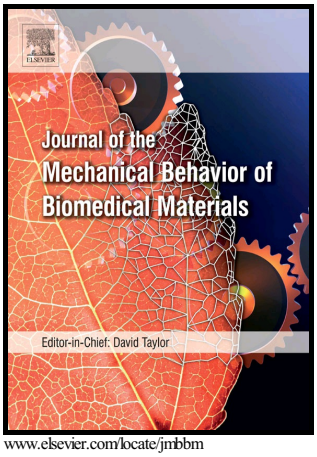

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Improving the long-term stability of Ti6Al4V abutment screw by coating micro/ nano-crystalline diamond films

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Abstract

Abutment screw loosening is the most common complication of implanting teeth. Aimed at improving the long-term stability of them, well-adherent and homogeneous micro-crystalline diamond (MCD) and nano-crystalline diamond (NCD) were deposited on DIO® (Dong Seo, Korea) abutment screws using a hot filament chemical vapor deposition (HFCVD) system. Compared with bare DIO® screws, diamond coated ones showed higher post reverse toque values than the bare ones ($p<0.05$) after cyclic loading one million times under 100 N, and no obvious flaking happened after loading test. Diamond coated disks showed lower friction coefficients of 0.15 and 0.18 in artificial saliva when countered with ZrO_2 than that of bare Ti6Al4V disks of 0.40. Though higher cell apoptosis rate was observed on film coated disks, but no significant difference between MCD group and NCD group. And the cytotoxicity of diamond films was acceptable for the fact that the cell viability of them was still higher than 70% after cultured for 72 h. It can be inferred that coating diamond films might be a promising modification method for Ti6Al4V abutment screws.

Keywords: HFCVD; MCD; NCD; long-term stability; friction coefficient; biocompatibility

1. Introduction

Since the introducing of osseointegration by Branemark [1], dental implanting has gained great prevalence in dentition defect repair for its outstanding functional and aesthetical effects as well as high long-term success rate. Abutment screws, playing a vital role in connecting the implant with abutment, are subjected to the occlusal force, resulting in complications such as loosening or fracture. Jung et al. [2] studied the 5-year survival and complication of implant-supported single crown, revealing that peri-implantitis and soft tissue complications occurred adjacent to 9.7% and 6.3% of the implants had bone loss exceeding 2 mm over the 5-year observation period. Strikingly, screw or abutment loosening rate comes to 12.7% after 5-year implanting, indicating that biological and particularly technical complications are frequent. Components loosening may not only result in implant failure, but also give rise to complications such as gum sensitivity, inflammation and hyperplasia, seriously affecting patients' daily life. No doubt should some effective measures be taken to solve this problem. Criteria such as preload, abutment design, interface adaptation and occlusion conditions may affect the stability of the screw. Researches showed that lower preload led to more connection fretting and finally to failure [3]. To provide connection protection and to increase fatigue lifespan by preloading, the preload should be 60% - 70% of the screw's yield strength [4, 5] since the average axial stress of transverse section equals