



Use of polyelectrolyte thin films to modulate Osteoblast response to microstructured titanium surfaces

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ABSTRACT

The microstructure and wettability of titanium (Ti) surfaces directly impact osteoblast differentiation *in vitro* and *in vivo*. These surface properties are important variables that control initial interactions of an implant with the physiological environment, potentially affecting osseointegration. The objective of this study was to use polyelectrolyte thin films to investigate how surface chemistry modulates response of human MG63 osteoblast-like cells to surface microstructure. Three polyelectrolytes, chitosan, poly(L-glutamic acid), and poly(L-lysine), were used to coat Ti substrates with two different microtopographies (PT, Sa = 0.37 μm and SLA, Sa = 2.54 μm). The polyelectrolyte coatings significantly increased wettability of PT and SLA without altering micron-scale roughness or morphology of the surface. Enhanced wettability of all coated PT surfaces was correlated with increased cell numbers whereas cell number was reduced on coated SLA surfaces. Alkaline phosphatase specific activity was increased on coated SLA surfaces than on uncoated SLA whereas no differences in enzyme activity were seen on coated PT compared to uncoated PT. Culture on chitosan-coated SLA enhanced osteocalcin and osteoprotegerin production. Integrin expression on smooth surfaces was sensitive to surface chemistry, but microtexture was the dominant variable in modulating integrin expression on SLA. These results suggest that surface wettability achieved using different thin films has a major role in regulating osteoblast response to Ti, but this is dependent on the microtexture of the substrate.

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1. Introduction

Osseointegration is critical for the success of dental and orthopaedic implants, especially for patients with bone pathology [1]. The primary interaction between a biomaterial and the surrounding bone involves the outermost molecular layers of the implant [2]. Thus, the surface micro-roughness [3,4], surface energy [5,6], and surface charge [7,8] of the biomaterial play important roles in influencing cellular response.

In order to improve osseointegration, many studies have been devoted to the modification of biomaterial surface properties [9]. Titanium surfaces with both micrometer and submicrometer scale

roughness have been shown to enhance osteoblast differentiation *in vitro* and bone formation *in vivo* [10]. The increased surface area associated with a higher degree of surface roughness provides a larger contact region with the surrounding tissue than that available with a smooth surface, and consequently, provides increased stability for tissue anchoring [11]. However, poor surface wettability due to increased surface roughness and adsorption of organic contaminants from the atmosphere can delay the initial interactions with tissue fluids and ultimately impact the rate and extent of new bone formation [12–14]. Enhanced surface wettability on rough titanium implant surfaces shortens wound healing time and increases tissue integration of titanium implants by forming conditioned protein layers, thereby reducing the gap between tissue and the biomaterial surface [6,15].

The adsorption of proteins on biomaterial surfaces is controlled to a great extent by surface chemistry and is the key parameter responsible for cell attachment and adhesion, spreading, and proliferation [16]. Therefore, *in vitro* studies using chemically

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