Osteointegration of titanium implant is sensitive to specific nanostructure morphology

V.V. Divya Rani, Lakshmanan Vinoth-Kumar, V.C. Anitha, Koyakutty Manzoor, Menon Deepthy *, V. Nair Shantikumar *

Amrita Institute of Medical Sciences & Research Centre, Amrita Centre for Nanosciences & Molecular Medicine, Amrita Lane, Ponekkara P O, Kochi, Kerala 682041, India

1. Introduction

The success of any orthopedic or dental implantation procedure is based on the formation of an effective interface between the surface of the implant material and the bone tissue, without any fibrous tissue intervention [1]. Current orthopedic implants are limited by the lack of appropriate cell adhesion and osteointegration, leading to reduced implant lifespan. Improvements in implant surface topography and composites to better mimic the surface roughness features of natural bone [5–10]. The principle behind surface structural modifications on implants at the nanoscale is that such surfaces would mimic the extracellular matrix with which cells normally interact and hence would favor positive interaction with cells [11]. Indeed, this principle has been verified in several cases. Various studies have shown that surface energy and nanotopography influence the type, quantity and conformation of adsorbed protein, and control cellular adhesion to the surface [12–17]. Specifically, the active site of vitronectin (RGD sequence) has been found to be more exposed on nano-pore-diameters (<100 nm), enhanced osteoblast cell functions [20], as well as endothelial cell proliferation without vascular smooth muscle proliferation [21]. Dalby et al. [5], in a detailed investigation on patterned polymeric surfaces with disordered arrangement of dots in square arrays, having a displacement of 50 nm between dots, showed enhanced osteoblast differentiation of hMSCs compared to an ordered substrate. All these reports highlight the significance of nanoscale substrate topographies in controlling cellular response.

In our previous study [22], we reported a simple, scalable, inexpensive and one-step wet chemical (hydrothermal) method for the...