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the effect of topography

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Control of fibroblast growth on nanocrystalline diamond films: The effect of topography
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INTRODUCTION: Nanocrystalline diamond (NCD) films have recently gained significant attention as biomaterials for a wide variety of applications, including orthopedic and neural devices [1,2]. A chief advantage of NCD surfaces is their ability to support diverse functional groups, which would allow controlling the biological performance of implants. Since most cell types avoid hydrophobic surfaces, H-terminated NCD (NCD-H) has been proposed as means to reduce cell attachment, but studies have shown conflicting results. Topography in the submicron- and nano-scale is another surface property that governs cell attachment on biomaterials [3]. However, the interaction of cells with textured NCD films has not been well investigated as yet. In this study, we aimed to explore the adhesion and growth of cells on NCD-H films displaying submicron topography with the perspective of applying these films to reduce cell growth on implanted neural electrodes.

METHODS: Corning Eagle XG glass and Grade 5 Ti foil were used for the fabrication of low and high roughness samples. NCD-H films were grown on the samples using a plasma-enhanced linear antenna microwave chemical vapor deposition apparatus operating at low pressures with a CH4-H2-CO2 chemistry [4]. The surface properties were investigated by Raman spectroscopy at 488 nm and atomic force microscopy (AFM) in the semi-contact mode. Samples were seeded with primary human fibroblasts (CRL2429) at a density of 8 x 10^3 cells/cm^2. Culture medium consisted of DMEM supplemented with fetal calf serum (10%) and antibiotics. Cell adhesion was assessed by means of wide-field fluorescence microscopy and scanning electron microscopy (SEM) after 24 h of culture. Cell proliferation was measured by a fluorescence-based assay after 2 and 4 days of culture. Untreated glass and Ti samples were used as controls.

RESULTS: Raman analysis of glass- and Ti-NCD samples revealed very homogeneous films, with similar spectral profiles and displaying more than 94% diamond (sp^3) levels. Surface roughness remained essentially as in the original substrates: low for glass-NCD (R_{RMS}=17±1 nm) and high for Ti-NCD samples (R_{RMS}=320±17 nm). Fibroblast growth rates were reduced by 50% on glass-NCD and 75% on Ti-NCD as compared to the untreated controls. The growth rate on Ti-NCD was about 90% smaller than that on glass-NCD. While cells on glass-NCD displayed an adhesion pattern similar to the untreated controls, the typical cell on a Ti-NCD surface was elongated, with a poor actin organization and small focal adhesions (Fig.1). SEM analysis revealed a direct correlation between cell flatness and growth rate.

DISCUSSION & CONCLUSIONS: These results indicate that NCD-H films deposited on substrates of submicron topography significantly impair cell adhesion and growth in vitro, which may represent an efficient approach to reduce cell attachment on the surface of medical implants.


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