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Osteoblastic Cell Behavior and Early Bacterial Adhesion on Macro-, Micro-, and Nanostructured Titanium Surfaces for Biomedical Implant Applications

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Abstract

Purpose: Surface treatments may significantly affect physical-chemical properties and surface biologic responses. This study aimed to investigate the influence of alterations in the physical-chemical properties of pure titanium with different surface topographies on biocompatibility and early microbiologic response.

Materials and methods: Titanium disks were exposed to five different surface treatments created through acid etching and anodizing methods. Surface morphology, 2D and 3D roughness, wettability, biocompatibility, and cell viability were evaluated. Osteoblast adhesion and bacterial adhesion tests were also executed. Data were statistically analyzed using analysis of variance followed by Tukey test, roughness ($P < .05$), and bacterial proliferation ($P < .05$).

Results: Five different surface morphologies were developed; double acid etching was shown to be significantly rougher than the others. The 2D roughness measurements were shown to be less consistent than the 3D measurements. All surfaces presented biocompatibility to allow cell behavior and differentiation. Osteoblasts presented better evolution in terms of adhesion and behavior in the nanomorphologies. High roughness significantly increased bacterial adhesion.

Conclusion: Surface treatments may critically alter titanium properties and morphology. Therefore, roughness measurements with a wide area should be used in their evaluation. Nanotextured surfaces show a positive effect on bone cells and antibacterial response; their application is suggested when considering surface texturization for biomedical implants.

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