Nano Composite Coating on Titanium with Anti-Cancer Activity: A Strategy for Preventing Oral Cancer Recurrence

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Abstract

The chemical modification of titanium implant surfaces significantly influenced their biological interactions. A novel surface design was developed that transitions from anticancer-inert to highly bioactive against oral squamous cell carcinoma (OSCC) cells. Titanium samples were coated using a combined anodizing and anaphoretic electrodeposition technique. The biological responses of coated (Ti/Coating) versus uncoated (Ti) titanium were evaluated in SCC-25 cells. Flow cytometry assessed apoptosis, cellular uptake, ROS generation, and cell cycle progression, while gene and protein expression were analyzed using qPCR and Western blot. The Ti/Coating surface significantly reduced cell viability, induced early apoptosis (via BAX upregulation and BCL2 downregulation), and caused G2/M cell cycle arrest. Increased ROS production contributed to cytotoxicity. Expression of EMT markers (VIM, SNAIL, SLUG) was inhibited, while CDH1 was upregulated, correlating with reduced cell migration. Furthermore, Ti/Coating suppressed AKT/mTOR and Wnt/β-catenin signaling pathways. These findings demonstrate that engineered titanium coatings can actively suppress OSCC cell proliferation and migration, offering a promising approach for bioactive implant surfaces with dual structural and therapeutic functions.

Keywords: *chitosan; coatings-cell interaction; nano-hydroxyapatite; oral cancer cells; selenium; surface-chemical modification*