Antimicrobial Silver/Titania Nanotube Surfaces (TiO_2-Nt-Ag) for Dental Implants

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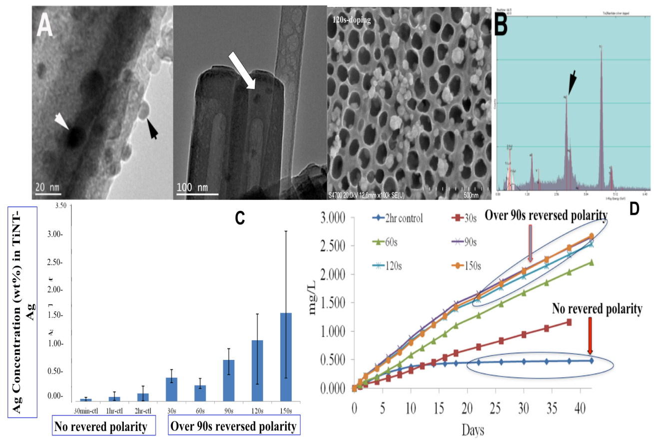
Statement of Purpose: With the advent of implantology, dentistry has been revolutionized. However, implant related complications still are prominent and difficult to treat, often requiring implant removal and repeated implantation. Initial implant associated complications may include mucositis and periimplantitis. Mucositis occurs when the peri-implant mucosa exhibits inflammation, and can be reversed with proper treatment. Periimplantitis can be defined as "an implant disturbance due to inflammation, with end result of bone resorption and inflammation."[1] It can be triggered by peri-implant lesions, aggressive bacteria, excessive mechanical stress, and corrosion.[2] Periimplantitis is hard to control as the biofilm that adheres is hard to remove, and possibly a more effective treatment is prevention of bacterial biofilm formation.[3] Nanotexturing of implant surfaces, particularly titanium oxide nanotubes (TiO2-Nt), has attracted attention tremendously in the last decade. Nanosurface on dental implants have shown a positive correlation with improved osseointegration in as little as twelve weeks. [4]

Materials and Methods: In order to create silver embedded TiO_2 nanotubes, a simple and cost effective electrochemical anodization technique was used. Titanium discs were used as substrate to synthesize the nanotubes. The anodization was carried out at room temperature with a constant 60 V DC. Post anodization, thermal annealing of the TNTs was performed in air at 450 ºC for 3 h with heating and cooling rates of 7. 5 ºC min−1.

Results: Here in we have successfully created a novel anodization method to incorporate Ag into TiO_2-Nt. Transmission Electron microscope (TEM) analysis reveals the presence of Ag embedded inside and outside of the TiO_2-Nt. Energy-dispersive X-ray spectroscopy (EDS) analysis confirmed the presence of Ag on the TiO_2-Nt.



A) TEM and SEM images depicting the presence of Ag inside (black arrow) and outside (white arrow) nanotubes; (B) EDS analysis depicting the presence of Ag element (black arrow) on the nanotubes; (C) control over concentration of embedded Ag ranging between 0.1wt% to 1.5 wt%; (D) Control over release of silver to maintaining it at doses way below the toxic does of 10mg/L.

Conclusion: This novel TiO_2-Nt-Ag surface is expected to perform superiorly mainly because Ag is embedded into the nanotubes resulting in more stable bonding between Ag and Nt. This novel Ag-Nt bonding creates a slow, constant and controlled release of Ag ions to kill bacteria, and simultaneously generates a minimum hazardous environment to the cells. This method provides a novel engineered nanostructure implant for an ideal tissue regeneration and antimicrobial benefits at the tissue - implant interface.

Reference:

[1]Mouhyi J, Dohan Ehrenfest DM, Albrektsson T. *Clin Implant Dent Relat Res*. 2012;**14**: 170

[2]Fu JH, Hsu YT, Wang HL.. *Eur J Oral Implantol*. 2012;**5 Suppl**: S91-103.

[3]Monteiro DR, Gorup LF, Takamiya AS, Ruvollo-Filho AC, de Camargo ER, Barbosa DB. *Int J Antimicrob Agents*. 2009;**34**: 103-10.

[4] Gao Y, Li Y, Xiao J, Xu L, Hu K, Kong L. *J Biomed Mater Res A*. 2012;100: 2159-67.