BACTERICIDAL PROPERTIES AND BIOCOMPATIBILITY OF TITANIUM IMPLANTS WITH TACU AND NBCU MAGNETRON-SPUTTERED COATINGS *IN VIVO*

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The prevention of implant-associated infections remains a critical challenge in orthopedic and reconstructive surgery. This study evaluated the bactericidal and biocompatibility characteristics of titanium implants with magnetron-sputtered TaCu and NbCu coatings compared to uncoated Ti6Al4V (BT-6) controls in a rabbit femoral model. Cylindrical rough and smooth implants were implanted into 24 rabbits, followed by inoculation with *Staphylococcus aureus* (1.0×10^8 CFU/mL) to induce controlled infection. Over a 21-day observation period, clinical, radiological, and confocal microscopy analyses were conducted to assess implant stability, tissue response, and bacterial biofilm formation.

The TaCu-coated implants demonstrated the lowest mortality rate (12.5%) compared to NbCu and Ti6Al4V groups (37.5% each), suggesting reduced systemic toxicity. No allergic reactions were observed in any group. Confocal microscopy revealed significantly reduced bacterial colonization and biofilm thickness on TaCu and NbCu surfaces compared to Ti6Al4V. Macroscopic and radiological analyses confirmed the presence of iatrogenic osteomyelitis (n=24), with implant instability observed in the Ti6Al4V (n=8) and NbCu (n=4) groups but not in the TaCu group. Statistical analysis using the Kruskal–Wallis test confirmed significant differences ($p = 0.048$) in surface adhesion between rough and smooth implants.

Overall, the TaCu and NbCu coatings demonstrated enhanced antibacterial performance and improved biocompatibility in vivo compared to conventional titanium alloys. These findings highlight the potential of Cu-doped magnetron-sputtered coatings as promising candidates for preventing implant-associated infections and improving osseointegration in orthopedic applications.

Keywords: *titanium implants, TaCu, NbCu, magnetron sputtering, bactericidal coatings, Staphylococcus aureus, osteomyelitis, biofilm, in vivo study*