Quorum Quenching on Titanium Surfaces: A Strategy to Reduce Virulence in Resistant Bacteria

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Introduction

Bacterial resistance is a major healthcare challenge caused by the misuse of antibiotics, leading to ineffective treatments for infections. In orthopedics and dentistry, biofilm formation on implants exacerbates the issue. A promising solution is quorum quenching, which disrupts bacterial communication, with lactonase enzymes showing potential to prevent biofilm and combat resistance.

Materials and methods

Ti6Al4V alloy disks were polished, cleaned, and chemically treated with acid etching and oxidation to prepare the surface (Ti6Al4V CT). After UV activation (Ti6Al4V CT+UV) and calcium treatment (Ti6Al4V CT+UV+Ca), surfaces were functionalized with ST1 lactonase enzyme solution using a concentration of 1000 µg/mL, creating the Ti6Al4V CT+UV+Ca+ST1 1000 sample.

Results

The modified titanium alloy is biocompatible and serves as an excellent platform for biological functionalization. Once confirmed that the enzyme functionalization was carried out through a zeta potential analysis, a real-quantitive PCR revealed that neither the enzyme nor the functionalized titanium samples exhibit traditional antibacterial properties. However, they effectively reduce gene expression related to quorum sensing and virulence factor production in *Pseudomonas aeruginosa* (*Figure 1*). Similar effects were not observed with *E. coli* and *S. aureus*.

Conclusions

The study demonstrates the potential of ST1 lactonase-functionalized Ti6Al4V alloys to combat bacterial resistance. These findings highlight the promise of quorum quenching as a strategy for biofilm prevention, particularly in implant applications.

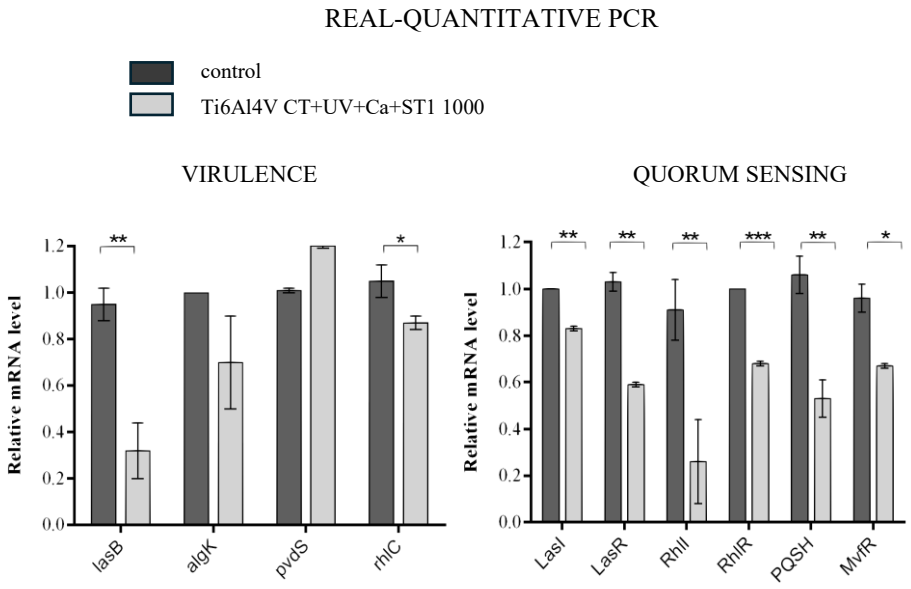


Figure 1: Real-quantitative PCR results for the control sample and the Ti6Al4V CT+UV+Ca+ST1 1000 sample