

Title: Zinc oxide nanoparticle-integrated biosensor: Dual approaches for diagnosing infections in orthopaedic trauma

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Abstract: C-reactive protein (CRP) is a commonly recognized inflammatory biomarker utilized during orthopaedic procedures and serves as a valuable metric for monitoring infections. In this study, a CRP biosensor was developed using both an aptamer and antibody integrated onto an interdigitated microelectrode (IDME) sensor. Zinc oxide nanoparticles were modified on IDME surface to enhance antibody immobilization. CRP detection was attained through two distinct approaches. In method 1, CRP was first introduced on antibody surface, followed by aptamer interaction. In method-2, a pre-mixed CRP-aptamer complex was applied on the antibody attached surface. The nanomaterial-assisted surface functionalization significantly improved antibody immobilization and the aptamer premixed with CRP strengthened the aptamer-CRP binding efficiency. As a result, the detection limit of CRP was lowered to 0.7 pg/mL, with a linear response from 0.7 to 25 pg/mL [$y = 3.0836x - 4.6842$; $R^2 = 0.9558$]. Additionally, CRP-spiked serum samples exhibited increased responses across all tested concentrations, with no signal interference, confirming the selective detection of CRP. Control experiments with other inflammatory biomarkers showed no response, further validating the specificity of developed biosensor. This study introduces two possible methods on a single platform with high-performance analysis.

Keywords: Biomarker ,C-reactive protein, Zinc oxide nanomaterial, Nanosensor

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