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Development of a biodegradable hydroxyapatite-PLGA-collagen biomaterial for bone regeneration

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Synthetic bone-graft materials are needed to repair bone fractures and bone defects caused by congenital disorders, traumatic injury, or surgical removal of bone tumors. A novel multistep polymerization and fabrication process has been developed to construct a collagen-based biomaterial for bone regeneration.Thisnano-hydroxyapatite (nHAP)-g-poly(lactide-co-glycolide)-g-collagen (nHAP-PLGA-collagen) biomaterialincorporates covalently bondedelementsto provide the necessary mechanical and biological properties suitable for a bone graft substitute.Covalent bonding between the components of the nHAP-PLGA-collagen biomaterialwas verified using thermal analysisand NMR and FTIR spectroscopies. FTIR results indicate chemical bonding between nHAP-PLGA and collagen. TGA analysis indicates that nHAP-PLGA-collagen is acting as a single material and also showed it has improved thermal stability compared to nHAP-PLGA or pure collagen. The nHAP-PLGA-collagenbiomaterial hasultimate tensile strength of3.4±1.1MPa, which is close to the range of human cancellous bone (7-20 MPa) and 300 times higher than the tensile strength of pure collagen (10-12 KPa).Two dimensional nHAP-PLGA-collagen films support mesenchymal stems cell (MSC) attachment and proliferation.With biocompatibility established, future studies will characterizeosteogenic differentiation of MSCs and bone formation.In summary, nHAP particles were used to initiate synthesis of PLGA polymer that was subsequently covalently attached to collagen molecules. The chemical linkage between nHAP-PLGA and collagen was verified and mechanical analysis shows that the novel biomaterial has mechanical properties similar to cancellous bone. It is expected that this novel biomaterial will enhance osteogenic differentiation of MSCs without compromising biocompatibility.

Biography

Timothy M Wick, PhD, is a Professor and Chair of the Department of Biomedical Engineering at the University of Alabama at Birmingham and co-Director of UAB's BioMatrix Engineering and Regenerative Medicine Center. He has more than 25 years of experience engineering, evaluating and validating biomedical systems and devices to solve health-related problems and improve healthcare technology to benefit society. He is a Fellow of the American Institute for Medical and Biological Engineering.He earned his Bachelor's degree in chemical engineering from the University of Colorado at Boulder and his doctorate in chemical engineering from Rice University.

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