

Public Abstract

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Title:THE STUDY AND DEVELOPMENT OF CALCIUM PHOSPHATE BONE CEMENT AND HYDROXYAPATITE NANOFIBERS

Among various synthetic bone graft substitutes, calcium phosphate cements (CPCs), typically made by mixing a powder and a liquid, are one of the primary choices for orthopedic surgeries. They can be manufactured in large quantity and are chemically similar to human hard tissues. However, depending on the specific formulas, CPCs may render poor properties, such as setting time, injectability and mechanical properties, which significantly limit their clinical applications. In order to have better understanding of the influence of the raw materials of the cements, including both powder and liquid, on the properties of the of calcium phosphate cements and to eventually develop a way to better control and improve cement properties, we have 1) developed a liquid recipe primarily containing sodium hydrogen phosphate (Na_2HPO_4) and sodium dihydrogen phosphate (NaH_2PO_4), which can regulate the setting time, injectability and mechanical strength of tetracalcium phosphate (TTCP) - dicalcium phosphate (DCPA) cements, 2) applied various polymer additives, including chitosan lactate (chitosan), poly (ethyleneimine) (PEI) and poly (allylamine hydrochloride) (PAH) to tailor the setting time, injectability and mechanical properties of polymer-apatite cement as a bone substitute, and 3) synthesized high aspect-ratio hydroxyapatite (HA) nanofibers, applied such HA nanofibers as additives to the cements, and also investigated the properties of the cement composites containing nanofibers. The chemical composition, microstructure, and mechanical properties of the raw materials and resulting calcium phosphate cements and composites have been characterized by X-ray Diffraction (XRD), scanning electron microscope (SEM), electron energy dispersive spectrometer (EDS), and Instron universal mechanical testing machine. Our results suggested that: 1) higher concentration of Na_2HPO_4 and NaH_2PO_4 in the cement liquid led to shorter setting time, lower injectability and lower mechanical strength of TTCP-DCPA cement; 2) chitosan can improve injectability of apatite cement significantly, and PEI, and PAH can greatly improve mechanical properties, and higher concentration of PEI and PAH cement liquid rendered shorter setting time, but the setting time of all three types of polymeric CPC was shown to exceed the optimal limits; 3) very unique evolution of reaction product was demonstrated during synthesis of HA nanofibers with high precursor content, and dissolution-evolution-precipitation mechanism for HA nanofibers crystal growth was discussed. 4) HA nanofibers were successfully included in the CPC to make a working paste with acceptable injectability and setting time by significantly increasing the amount of liquid (lowering the powder to liquid ratio), but the reinforcing effects of HA nanofibers have not been observed. The results of our experimental work and analysis indicated that there are multiple ways to tailor the cement properties and further investigation is needed to make calcium cements with different properties that may meet each of the variety of orthopedic applications.