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Research paper

Reinforcement of calcium phosphate cement with multi-walled carbon nanotubes and bovine serum albumin for injectable bone substitute applications

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ABSTRACT

This paper presents the development of novel alternative injectable calcium phosphate cement (CPC) composites for orthopaedic applications. The new CPC composites comprise β-tri-calcium phosphate (β-TCP) and di-calcium phosphate anhydrous (DCPA) mixed with bovine serum albumin (BSA) and incorporated with multi-walled carbon nanotubes (MWCNTs) or functionalized MWCNTs (MWCNTs–OH and MWCNTs–COOH). Scanning electron microscopy (SEM), compressive strength tests, injectability tests, Fourier transform infrared spectroscopy and X-ray diffraction were used to evaluate the properties of the final products. Compressive strength tests and SEM observations demonstrated particularly that the concomitant admixture of BSA and MWCNT improved the mechanical properties, resulting in stronger CPC composites. The presence of MWCNTs and BSA influenced the morphology of the hydroxyapatite (HA) crystals in the CPC matrix. BSA was found to act as a promoter of HA growth when bounded to the surface of CPC grains. MWCNT–OH-containing composites exhibited the highest compressive strengths (16.3 MPa), being in the range of values for trabecular bone (2–12 MPa).

1. Introduction

The improved life expectancy in developed countries has led to a significant rise in the number of musculoskeletal disorders, such as osteoporosis and osteoarthritis (Bohner, 2000). Minimally invasive surgical techniques have been shown to have important clinical potential for stabilizing such disorders (Mermelstein et al., 1998). Bio-resorbable calcium phosphate cements (CPCs) represent an interesting alternative to traditional bone graft materials. Moreover, CPC is a highly desirable material for orthopaedic applications due to its mouldability, *in situ* self-hardening ability, excellent

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