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Novel Injectable Calcium Phosphate Bone Cement from Wet Chemical Precipitation Method

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Abstract. Calcium phosphate cement has been prepared via chemical precipitation method for injectable bone filling materials. Calcium hydroxide, $Ca(OH)_2$, and diammonium hydrogen phosphate, $(NH_4)_2HPO_4$, were used as calcium and phosphorus precursors respectively. The synthesized powder was mixed with water at different powder-to-liquid (P/L) ratios, which was adjusted at 0.8, 0.9, 1.0, 1.1 and 1.2. The influence of P/L ratio on the injectability, setting time and mechanical strength of calcium phosphate cement paste has been evaluated. The synthesized powder appeared as purely hydroxyapatite with nanosized and agglomerated spherical particles. All cement pastes show excellent injectability except for the paste with P/L ratio 1.2. Calcium phosphate cement with P/L ratio 1.1 shows the ideal cement for bone filler application with good injectability, the initial and final setting times of 30 min and 160 min, and the compression strength of 2.47 MPa. The result indicated that the newly developed calcium phosphate cement is physically suitable for bone filler application. This paper presents our investigation on the effect of P/L ratio on the handling and mechanical properties of calcium phosphate cement prepared via wet chemical precipitation method.

1. Introduction

Calcium phosphate cement (CPC) is clinically accepted for bone cement application. This is attributed to their excellent biological properties, injectability and ability to harden *in vivo* [1,2]. CPC can be moulded and shaped to fill the defect sites by using injection needle. The commercial CPC is made of tetracalcium phosphate (TTCP) and α–tricalcium phosphate (α-TCP) which will transform to hydroxyapatite (HA) upon contact with water, forming apatite cements [3].

CPC can be synthesized via dry methods (i.e. solid-state and mechanochemical synthesis) and wet methods (i.e. chemical precipitation, hydrolysis, sol-gel, hydrothermal, emulsion and sonochemical methods) [4]. Wet chemical methods is the most common method used in preparation of HA due to their ability to control the morphology and mean size of CPC as well as its pore size by adjusting the reaction parameters compared to dry methods [4,5]. The synthesis of CPC via wet chemical precipitation method is the most favorable route due to the ease in experimental procedure, low synthesis temperature, high homogeneous purity products, low cost as well as high yield [4-10].