INFLUENCE OF MAGNESIUM ON THE WORKING CHARACTERISTICS OF BRUSHITE CEMENTS

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The present work aims at adressing some questions raised by a previous *in vitro* study on the long term aging of brushite cements in simulated physiological conditions. In said study, the following compositional factors were investigated : (A) nature of rheological additive (hyaluronic acid, HA, *vs* hydroxypropylmethyl cellulose, HPMC ; appr. 1%wt of mixing solution) ; (B) origin of sulfate ions (plaster of Paris, $CaSO_4 \bullet 0.5H_2O$ *vs* H_2SO_4 diluted in mixing solution ; S/Ca = 0.013) ; (C) addition of magnesium phosphate (0 %wt *vs* appr 8.5 %wt $MgHPO_4 \bullet 3H_2O$), and (D) final cement porosity (35 *vs* 45 %vol). The results have shown that Mg addition increases significantly the degradability of the cements, particularly so in the presence of HA.

Therefore, a more thorough characterisation of these cement formulations has been undertaken : thus, the characteristic working and setting times, the ultimate conversion degree of the cements and their mechanical properties have been investigated. Working and setting times, toghether with ultimate conversion degrees were estimated by a thermometric analysis technique developed previously by C. Pittet [1], based on the exothermicity of the consolidation processes. Mechanical properties were evaluated by combining uniaxial compression and diametral compression tests. The results have shown that the presence of Mg results in lower ultimate conversion and, as a consequence, in lower mechanical strength.

In order to highlight the Mg effects, a further thermometric study has been undertaken : in this study, various concentrations of Mg were incorporated in the cement in the form of $MgSO_4$ dissolved in the mixing solution ; Mg concentrations were selected so as to represent either 50% or 100% of the saturation concentration of Newberryite ($MgHPO_4 \bullet 3H_2O$).

The results confirm a specific interaction between dissolved Mg and HA : in the presence of HPMC, Mg addition does not affect significantly the characteristic working and setting times ; in contrast, these characteristic times are significantly shortened by the simultaneous presence of HA and Mg in the mixing solution. These effects are consistent with the way Mg affects the ultimate conversion degree and the mechanical performance of the cements, which also varies according to the nature of the polymer present in the mixing liquid.

In conclusion, the presence of Mg dissolved in the intersticial liquid present in brushite cements affects significantly their working characteristics, including working and setting times, ultimate degree of conversion and mechanical performances. These effects depend markedly on the nature of hydrosoluble polymers dissolved in the mixing liquid : a specific interaction seems to exist between Mg and hyaluronic acid. It is expected that different Mg-hydrosoluble polymer combinations might result in variable degradabilities and *in vivo* responses.

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[1] C.Pittet "Development and characterization of injectable calcium phosphate cements for use in vertebroplasty." PhD Thesis work n°2059, EPFL Lausanne, 2001.