



Influence of the liquid phase content and presence of hydroxypropyl methyl cellulose on the properties of a calcium phosphate bone cement

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–20 °C and 2 h at room temperature. For FT_{NaCl} samples, an aqueous solution of NaCl (25% w/w) was pre-added to the initial polymer solution in a proportion of 1:10 (v/v) relative to PVA. The hydrogels were characterised concerning equilibrium water content (EWC), surface morphology (analysed by Scanning Electron Microscopy (SEM, JEOL JSM-7001F)), thermotropic behaviour (studied by differential scanning calorimeter (NETZSCH 200 F3 Maia) with thermograms being recorded over the range of 20–280 °C at a heating rate of 10 °C/min), mechanical performance (evaluated by uniaxial tensile and unconfined compression tests carried out in a TA.XT Express Texture Analyzer) and friction behaviour (pin-on-disc tests done in linear reciprocal oscillation mode using stainless steel 316L balls as counter-bodies, with loads of 10 and 20 N, in phosphate buffered saline (PBS) solution and simulated synovial fluid (SSF) solution with hyaluronic acid and bovine serum albumin).

Results: CD₄ and CD₃₀ showed an EWC in the range of 63–66% while that of FT₀ and FT_{NaCl} varied between 87–89%. SEM micrographs revealed different structures for CD and FT samples. The surface of CD gels was smoother with no evident porosity, while FT materials exhibited holes in different porosity patterns. FT_{NaCl} presented smaller pores than FT₀, although a minor number of large pores coexist. The degree of crystallinity (35–36%), glass transition temperature (43–44 °C), and melting transition temperature (214–216 °C) were similar for all samples. Regarding mechanical performance, the elastic modulus in both compression and tensile, was inferior for the FT materials, in particular for FT_{NaCl}. In tensile experiments, CD gels had the highest ultimate tensile strength and toughness. Concerning tribology behaviour, the friction coefficients (CoF) of all samples were low and similar in PBS solution when 10 N of force was applied. For 20 N, the CoF values of the CD materials decreased. In SSF solution, CD samples presented higher CoF with both tested forces.

Discussion and conclusions: The properties of the PVA hydrogels were strongly influenced by the preparation conditions. CD method proved to be more suitable for producing PVA cartilage substitutes. It led to more compact, rigid, and resistant materials with adequate values of EWC and CoF.

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ABSTRACT

Introduction: Calcium phosphate cements (CPCs) have been widely used for bone defects filling given their excellent biocompatibility, osteoconduction ability and ease of manipulation [1]. Nevertheless, their mechanical properties and handling performance still need to be improved to satisfy clinical requirements. Indeed, enhancing their injectability can widen its application to minimally invasive surgical procedures [2]. This work aims to investigate the effect of the liquid phase amount and presence of hydroxypropyl methyl cellulose (HPMC) on the basic properties of a commercial CPC containing a polymeric adjuvant, chitosan (Chi).

Materials and methods: Starting from the original formulation containing Chi, samples with different amounts of liquid phase (LP 30%, 38%, 42%, 50%) were prepared. Additionally, for LP 38% and 42% formulations, Chi was replaced by HPMC polymer. Setting times were measured using the Vicat apparatus. After 6 days of setting, mechanical properties were studied through compression assays and Vickers hardness was measured. Injectability experiments were done and

Table 1. Effect of the LP content on the properties of the Chi containing CPC.

LP content (%)	Initial setting time (min)	Final setting time (min)	Compressive strength (MPa)	Hardness (HV)	Injectability (%)
30	6.5	7.5	9.53±1.00	10.56±1.27	Not injectable
38	11.5	14	9.49±0.80	13.25±1.38	30.65±2.28
42	12.25	15.25	7.66±0.56	12.21±0.55	91.04±0.71
50	24	32	0.83±0.20	2.48±0.62	a)

a) Not tested because the setting times and mechanical properties do not suit clinical applications.

the cytotoxicity of the commercial CPC was assessed using MG63 and NIH/3T3 cell lines following the ISO 10993-5 guidelines.

Results: As shown in Table 1, increasing the LP content from 30% to 50% increased the initial setting time from 6.5 min to 24 min, and the final setting time from 7.5 min to 32 min. Concerning the resistance to compression, it was lowered from 9.53 ± 1.00 MPa to 0.83 ± 0.20 MPa. Regarding materials' hardness, it decreased by 77%. Injectability measurements showed that only 38% and 42%LP formulations could be injected. Nonetheless, while 38%LP formulation presented an injectability of 31 ± 2%, 42%LP formulation showed an injectability of 91 ± 1%. As for the addition of HPMC, for 38%LP formulation an initial setting time of 6.5 min and a final setting time of 10.5 min were measured, and for 42%LP formulation 12 min and 14.5 min, respectively. The mechanical properties presented similar values regardless the added polymer. Moreover, the formulations containing HPMC presented 69 ± 6% injectability for 38%LP and 94 ± 1% for 42%LP. Finally, when in contact with extracts of the commercial CPC for 24 h, the studied cell lines presented viability greater than 75% when compared to unexposed cells.

Discussion and conclusions: Our study shows that LP content has a significant impact on the CPC studied properties. Effectively, for 38 and 42%LP the setting times, resistance to compression and hardness of the materials assume suitable values for their use as trabecular bone defect fillers. For the Chi CPC, 42%LP formulation is ~200% more injectable than the 38%LP one. Even though the replacement of Chi by HPMC does not affect the mechanical properties significantly, HPMC itself seems to promote injectability, increasing it by 126%. Finally, the commercial CPC does not show a cytotoxic effect under the conditions of this assay.

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Layer-by-layer coated silicone-based soft contact lens hydrogel for diclofenac sustained release

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ABSTRACT

Introduction: Soft contact lenses (SCLs) constitute a promising vehicle for ocular drug delivery due to their biocompatibility, prolonged contact with the eye and general acceptance. Soaking in the drug solution is the simplest method to load the drug into the SCLs. However, it usually does not ensure a controlled drug release, compatible with the therapeutic needs. Thus, additional approaches, such as the application of coatings on the SCLs that constitute a barrier to the drug release, have been tried to achieve that purpose [1]. The main goal of this work is to investigate the possibility