Ready-to-use injectable Calcium Phosphate Foams: Simplifying the surgeon's job

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Background:

There are currently synthetic bone grafts that present attractive features, such as macroporosity in ceramic blocks or granules, or mouldability in cements and putties.

Aim:

This study aims at developing a bone substitute that gathers these advantages in a single material, together with ease of use: the fabrication and characterisation of a ready-to-use, injectable and self-setting calcium phosphate foam is studied.

Materials and methods:

Self-setting calcium phosphate foams (CPF) were prepared using a variable percentage P of Pluronic F127 (Thermoresponsive) in α-TCP (P%-CPF) as powder phase and 1\%wt Tween80 in water as liquid phase using a liquid-to-powder ratio of 0.55mL/g. After preparation the CPFs contained in a syringe were frozen at -80ºC. Unfreezing was performed using a milk heater (Medela, Switzerland) suitable for use with 3mL syringes. Porosity was characterized after setting of the CPFs by Mercury intrusion Poresimetry (MIP), Hg immersion and He picnometry.

Results:

All materials prepared resulted in after setting in a highly porous hydroxyapatite, with a total porosity increasing from 78\% for 0%-CPFs up to 84\% for 15%-CPF with a maximum coefficient of variation inferior to 2\% (Fig.1a, 1b). The addition of Pluronic allowed tuning the macropore entrance size (Fig 2b). The 10%-CPF was selected to evaluate the storage possibilities through freezing. Unfreezing for different times led to two different consistencies, due to the thermoresponsive properties of Pluronic F127: liquid-like, after 5min of unfreezing and gel-like after 10min, with a final total porosity of 77.26\%±2.57\%and 74.27\%±2.79 respectively.

Conclusions and clinical implications:

We designed injectable macroporous calcium phosphate foams which could be stored frozen ready-to-use, for surgeon friendly versatile use. These are the first self-setting calcium phosphate bone substitutes combining an immediate interconnected network of macropores, injectability, gel-ability, and ease of preparation and use.

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