

Bioresorption of Bone Substitutes Based on Calcium Phosphates

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As regenerative bone therapies are developing in the fields of maxillo-facial, orthopedic and spine surgeries, bioresorbable bone substitutes attract a growing interest. Resorbable polymers such as poly(L-lactide) (PLLA), poly(glycolide) (PGA) and mixtures thereof have long been used for the manufacture of osteosynthesis plates and screws ; more recently, these materials have been used either for making macroporous bone substitutes, or for preparing 3D macroporous templates for bone tissue engineering.

The use of bone substitutes based on calcium phosphates, in the form either of macroporous ceramic blocks or of injectable cement pastes of various compositions, has also gained popularity during the recent years. New developments are now focusing on polymer-matrix composites reinforced with nanocrystalline hydroxyapatite, thus attempting to mimic the composition and mechanical properties of natural bone.

The bioresorption process of bone substitutes obviously depends on their chemical nature. In contrast with PLLA and PGA, the resorption of which relies on their spontaneous hydrolysis and subsequent depolymerization in aqueous media, the resorption of calcium-phosphate substitutes is closely related with their solubility in aqueous solutions.

Thermodynamic simulations show that among the calcium phosphates used in the preparation of ceramic and cementitious bone substitutes, only mono-calcium phosphate monohydrate (MCPM), di-calcium phosphate dihydrate (DCPD, *alias* brushite) and octa-calcium phosphate (OCP) can dissolve spontaneously in normal physiological conditions (37°C, pH = 7.4). Other typical compounds, such as hydroxyapatite (HA) and β -tricalcium phosphate (β -TCP), can only dissolve in more acidic conditions that occur during acute inflammatory reactions, or result from osteoclastic activity.

The bioresorption of calcium phosphate bone substitutes (cements and macroporous ceramics) will be discussed in the light of their physico-chemical interactions with the physiological environment during bone remodeling