

Calcium phosphate cements (CPCs) as carriers of trace elements

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Abstract

Statement of the Problem: With the increasing standard of living and extending lifespan, an expanding number of patients are suffering from various skeletal dysfunctions. To reconstruct bones, materials of biological origin (allografts, autografts, xenografts) as well as synthetic ones are used. Among the last group of materials are calcium phosphate cements (CPCs), which are ideal for use in promoting bone healing as well as improving functionality in diseased or damaged tissue. The advantage of CPCs is unquestionably their chemical composition, which makes them bioactive. These are composed of calcium phosphates, thus showing high chemical similarity to the bone mineral phase (Ca/P). Other advantages include lack of cytotoxicity, osteoinductivity, osteoconductivity, ease of preparation, suitable setting time, and low price. Moreover, CPCs are characterized by both micro- and macroporosity which promotes cell proliferation, as well as diffusion of nutrients and metabolites.[1,2] Notably, natural bone is composed of various inorganic elements besides Ca^{2+} and PO_4^{3-} , for example, Mg^{2+} , K^+ , Fe^{2+} , Zn^{2+} , Mn^{2+} , V^{5+} , BO_3^{3-} and CO_3^{2-} . [3] These ions are involved in various metabolic pathways; are needed for the proper enzymatic reactions; are required to modulate equilibrium conditions in osteoblasts, osteoclasts and osteocytes. For instance, the supplementation of Mg^{2+} allows for improved adhesion, proliferation and differentiation of osteoblastic cells, increases the expression of osteogenic markers, ensures osteoconductivity and osteointegration. In turn, Zn^{2+} ensures antibacterial properties, meanwhile encouraging osteoblast differentiation. On the other hand, V^{5+} exhibits osteogenic abilities, thanks to capacity to mimic insulin and growth factors.[4] The last noteworthy element is Mn^{2+} , which is an important cofactor for several enzymes. It is also involved in the biosynthesis of chondroitin sulfate, a component of the extracellular matrix (ECM).[5]

Conclusion & Significance: CPCs can be used to deliver relevant trace elements (Mg^{2+} , Zn^{2+} , Mn^{2+} , V^{5+}), which can provide additional functionality.

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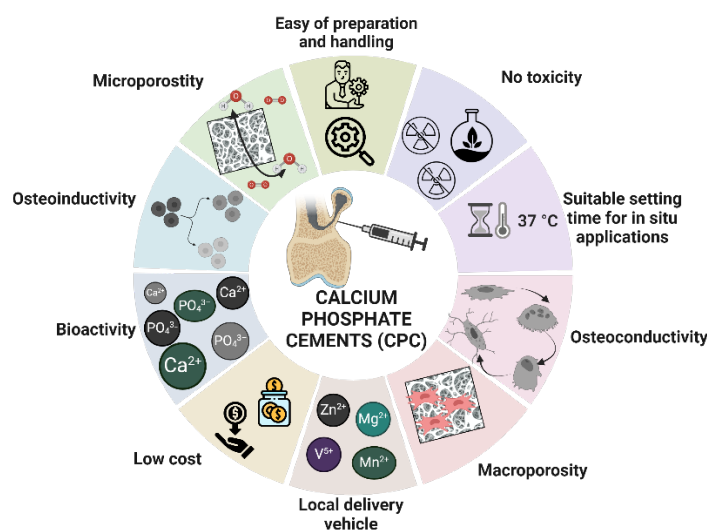


Figure. Advantages of calcium phosphate cements (CPCs)

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Photograph



Biography

Scientific activity of prof. Agnieszka Sobczak-Kupiec mainly concerns issues related to biomaterials intended for the regeneration of the musculoskeletal system, carriers of active substances and nanomaterials. She works at the Faculty of Materials Engineering and Physics, in the Department of Materials Engineering I-1, editor-in-chief of the "Material Engineering" magazine. Member of the Scientific Council of the Center for Excellence in Scientific Research, PK, member of the Mission Board "Assembly for the mission board on cancer", operating at the European Commission, DG Research & Innovation. She was and is the manager and contractor of several research projects, including those financed by the National Science Center, NCBR, MNiSzW, FNP.