Fabrication of self-setting β-tricalcium phosphate granular cement as a bone substitute

福田, 直志

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氏　　名　：福田　直志

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論　文　内　容　の　要　旨

β-tricalcium phosphate (β-TCP) granules have been used as bone substitute in dental, maxillofacial and orthopaedic surgery due to its osteoconductivity and bioresorbability. However, β-TCP granules implanted in bone defect tend to migrate or flow out from the implantation site, causing implant failure. To address this problem, β-TCP granules with setting property, or named β-TCP granular cement (β-TCP GC) may be one of the promising biomaterials utilized for the reconstruction of bone defect. In this study, β-TCP GC was prepared and its effectiveness was evaluated using rat calvarial bone defect model. First, β-TCP GC was made by mixing β-TCP granules and an acidic calcium phosphate solution, which is prepared by saturating monocalcium phosphate monohydrate (MCPM) with 0.6mol/L phosphoric acid. The β-TCP GC was set to form interconnected porous structure approximately 1 min after mixing. SEM observation revealed that plate-like crystals bridged the β-TCP granules. XRD analysis showed that the newly formed crystals were dicalcium phosphate dihydrate (DCPD), which is the most stable calcium phosphate phase at acidic environment. Although this β-TCP GC with self-setting property is useful for clinical application, too fast setting, 1min, was the drawback for its clinical use. Then, the setting time of β-TCP GC was regulated by adding citric acid known as an inhibiter for crystal growth of DCPD. It was found that the setting time became 5min by adding 0.1mol/L citric acid. Amount of DCPD formed in the set β-TCP GC decreased with increase in citric acid concentration, and crystal morphology of DCPD became elongated. Tissue response to β-TCP GC was histologically evaluated using critical size (ϕ 9.0 mm) calvarial bone defect model in rats after 2 and 4 weeks of implantation using β-TCP granules as control. Four weeks after implantation, amount of the formed bone was the same between β-TCP GC and β-TCP granules even though amount of the newly formed bone was smaller in the case of β-TCP GC with citric acid when compared to β-TCP granules 2 weeks after implantation. In conclusion, the β-TCP GC fabricated in this study has a good potential value to be used as a cement in bone reconstruction.