Fabrication and Tissue Response to Self-setting β-Tricalcium Phosphate Granules Cement

Kunio Ishikawa

Department of Biomaterials, Faculty of Dental Science Kyushu University

3-1-1, Maidashi, Higashi-ku, Fukuoka 812-8582 JAPAN

[a]ishikawa@dent.kyushu-u.ac.jp

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Abstract.

Sintered beta-tricalcium phosphate [β-TCP: β-$Ca_3(PO_4)_2$] granules have been used as an artificial bone substitute since β-TCP shows excellent osteoconductivity and replaced to bone. Also, the bone defect can be reconstructed by simply filling it with the granules. However, β-TCP granules often flow out from the defect, which is a key drawback when using β-TCP granules. On the other hand, dicalcium phosphate dihydrate [DCPD: $CaHPO_4 \cdot 2H_2O$] forming cement set to form DCPD upon mixing β-TCP powder with its acidic liquid phase. Based on the principle of DCPD forming cement, self-setting β-TCP granules cement is proposed.

When mixed with acidic calcium phosphate solution, β-TCP granules were found to readily set, forming a fully-interconnected porous structure as shown in Fig. 1. Fig. 2 shows the SEM image of (a) β-TCP granules, (b) set β-TCP granules and (c) contacted area of set β-TCP granules. XRD analysis revealed the formation of DCPD upon mixing the β-TCP granules with the acidic calcium phosphate solution. In other words, upon mixing, DCPD crystals formed on the surface of β-TCP granules, bridging the granules and resulting in the setting reaction.

The setting time of the β-TCP granular cement (β-TCP GC) was approximately 1 min and its mechanical strength, in terms of diametral tensile strength, was approximately 0.8 MPa.

Fig. 3 summarizes the histological results of (a, c) β-TCP granular and (b, d) β-TCP GC (a, b) 2wks and (c, d) 4wks after surgery. The β-TCP GC and β-TCP granules both showed the same level of osteoconductivity within rat calvaria bone defects. At 2 and 4 weeks post-implantation, new bone formation was comparable between the two β-TCP based bone substitutes.

It is concluded, therefore, β-TCP GC has excellent potential for use as a cement in bone defect reconstruction.

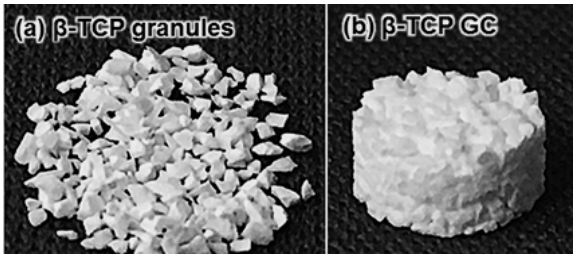

Fig. 1 Typical photo of (a) β-TCP granules and (b) β-TCP granules after mixed with an acidic calcium phosphate solution.

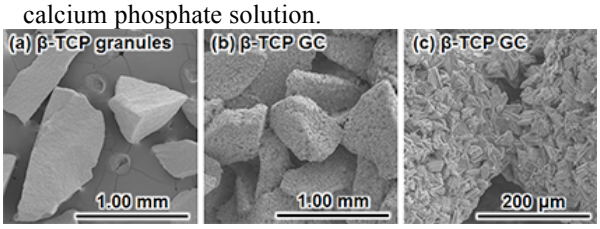

Fig. 2 Typical SEM images of (a) β-TCP granules, (b) set β-TCP granules and (c) contacted area of set β-TCP granules.

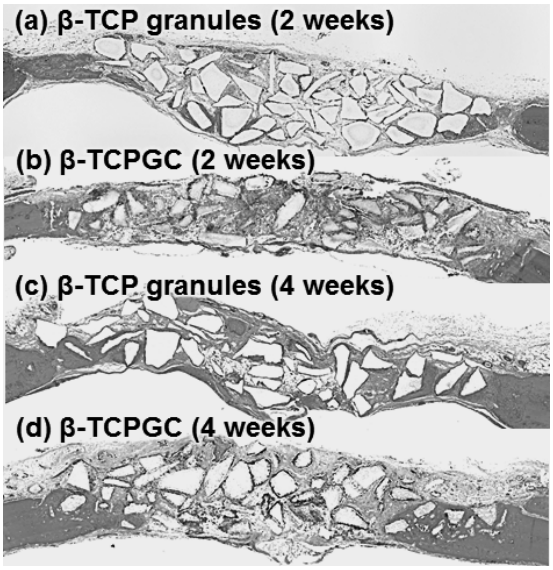

Fig 3 Histological images of (a) β-TCP granules 2wks after surgery, (b) β-TCP granular cement 2wks after surgery, (c) β-TCP granules 4wks after surgery, (d) β-TCP granular cement 4wks after surgery.