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Fabrication of calcium sulfate hemihydrate coated β-tricalcium phosphate through dissolution precipitation reaction

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Introduction: Previously, we had proposed that beta tricalcium phosphate granular cement (β-TCPGC) is useful to prevent flowing out of the β-TCP granules from the bone defect. When the β-TCP granules were mixed with acidic calcium phosphate solution, it set to form interconnected porous structure. Although it seems promising, β-TCP granules need to be mixed with the acidic calcium phosphate solution. Calcium sulfate hemihydrate (CSH) has self-setting ability by converting to calcium sulfate dihydrate (CSD) when exposed to water. Furthermore, CSD is the component of Osteoset®, which is a commercially available as a bone substitute. In this study, we fabricated CSH coated β-TCP granules through dissolution-precipitation method. This setting ability could inhibit the flowing out of the β-TCP granules from the bone defect.

Experimental Method: β-TCP granules were immersed in NaHSO4 solution for 1, 3, 5 and 7 days at 70°C. The samples were then heated at 120°C for 4 hours. β-TCPGC was prepared by mixing the granules with saline solution at a L/P ratio of 0:3 and identified by XRD and SEM. The mechanical strength of the β-TCPGC was measured as a DTS by universal testing machine. β-TCPGC was implanted in rabbit femur for 4 weeks and the percentage of newly formed bone was calculated from histological analysis.

Results: β-TCP granules immersed in NaHSO4 solution were coated by CSD and CSD became CSH after heating at 120°C for 4 hours. CSH coated β-TCP granules mixed with saline solution were set and DTS value of β-TCPGC with 75 wt.% of CSH was 0.8±0.1 MPa. The percentage of newly formed bone of β-TCPGC with 75 wt.% of CSH was 28.7±0.5%. Meanwhile, β-TCP granules without coating were 19.9±1.1%.

Conclusion: CSH coated β-TCP were successfully fabricated and formed interconnected porous structure with good mechanical strength after mixing with saline solution

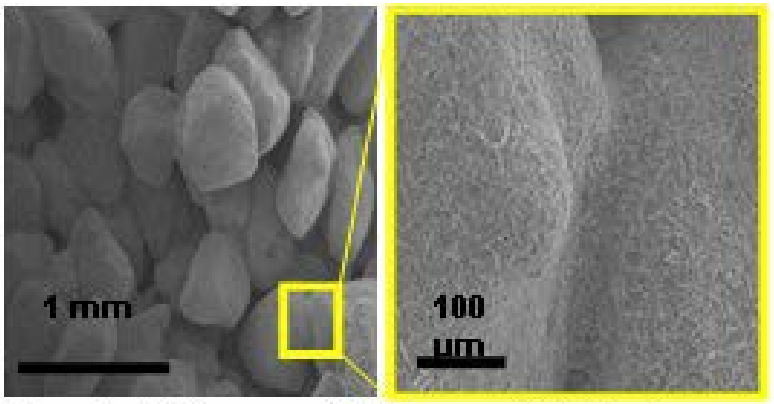

Figure 1: SEM images of CSH coated β-TCP after mixed with saline solution and formed interconnected porous structure.

Recent publications

1. Fukuda N, Tsuru K, Mori Y and Ishikawa K (2017) Fabrication of self-setting β-tricalcium phosphate granular cement. J Biomed Mater Res: Part B-App Biomater. 106(2):800-807.
2. Fukuda N, Tsuru K, Mori Y and Ishikawa K (2017) Effect of citric acid on setting reaction and tissue response to β-TCP granular cement. Biomed Mater. 12(1):15027.

3. Shariff K A, Tsuru K and Ishikawa K (2017) Fabrication of dicalcium phosphate dihydrate-coated β-TCP granules and evaluation of their osteoconductivity using experimental rats. Mater Sci Eng C Mater Biol Appl. 1(75):1411-1419.
4. Ishikawa K, Putri T P, Tsuchiya A, Tanaka K and Tsuru K (2017) Fabrication of interconnected porous -tricalcium phosphate(-TCP) based on a setting reaction of -TCP granules with HNO3 followed by heat treatment. J Biomed Mater Res: Part A-App Biomater Nov 27. Doi: 10.1002/jbm.a.36285.
5. Shariff K A, Tsuru K and Ishikawa K (2016) Fabrication of interconnected pore forming α-tricalcium phosphate foam granules cement. J Biomater Appl. 30(6):838-45.

Biography

Eddy Eddy is a dentist by training, graduated from Universitas Padjadjaran, Bandung, Indonesia in 2012. He continues his study as a PhD student in the Department of Biomaterials, Faculty of Dental Science in Kyushu University, Japan until present. His main research interest is the development and fabrication of artificial bone graft to fill defects in bones then afterwards replaced to new bone. He has presented his research at many international conferences.

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