



3D Porous Architecture of Stacks of β -TCP Granules Compared with That of Trabecular Bone: A microCT, Vector Analysis, and Compression Study

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Résumé en
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The 3D arrangement of porous granular biomaterials usable to fill bone defects has received little study. Granular biomaterials occupy 3D space when packed together in a manner that creates a porosity suitable for the invasion of vascular and bone cells. Granules of beta-tricalcium phosphate (β -TCP) were prepared with either 12.5 or 25 g of β -TCP powder in the same volume of slurry. When the granules were placed in a test tube, this produced 3D stacks with a high (HP) or low porosity (LP), respectively. Stacks of granules mimic the filling of a bone defect by a surgeon. The aim of this study was to compare the porosity of stacks of β -TCP granules with that of cores of trabecular bone. Biomechanical compression tests were done on the granules stacks. Bone cylinders were prepared from calf tibia plateau, constituted high-density (HD) blocks. Low-density (LD) blocks were harvested from aged cadaver tibias. Microcomputed tomography was used on the β -TCP granule stacks and the trabecular bone cores to determine porosity and specific surface. A vector-projection algorithm was used to image porosity employing a frontal plane image, which was constructed line by line from all images of a microCT stack. Stacks of HP granules had porosity ($75.3 \pm 0.4\%$) and fractal lacunarity (0.043 ± 0.007) intermediate between that of HD (respectively $69.1 \pm 6.4\%$, $p < 0.05$ and 0.087 ± 0.045 , $p < 0.05$) and LD bones (respectively $88.8 \pm 1.57\%$ and 0.037 ± 0.014), but exhibited a higher surface density ($5.56 \pm 0.11 \text{ mm}^2/\text{mm}^3$) vs. 2.06 ± 0.26 for LD, $p < 0.05$). LP granular arrangements created large pores coexisting with dense areas of material. Frontal plane analysis evidenced a more regular arrangement of β -TCP granules than bone trabecule. Stacks of HP granules represent a scaffold that resembles trabecular bone in its porous microarchitecture.

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