Three-dimensional arrangement of β-tricalcium phosphate granules evaluated by microcomputed tomography and fractal analysis.

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Résumé en anglais	The macrophysical properties of granular biomaterials used to fill bone defects have rarely been considered. Granules of a given biomaterial occupy three-dimensional (3-D) space when packed together and create a macroporosity suitable for the invasion of vascular and bone cells. Granules of β-tricalcium phosphate were prepared using polyurethane foam technology and increasing the amount of material powder in the slurry (10, 11, 15, 18, 21 and 25g). After sintering, granules of 1000-2000μm were prepared by sieving. They were analyzed morphologically by scanning electron microscopy and placed in polyethylene test tubes to produce 3-D scaffolds. Microcomputed tomography (microCT) was used to image the scaffolds and to determine porosity and fractal dimension in three dimensions. Two-dimensional sections of the microCT models were binarized and used to compute classical morphometric parameters describing porosity (interconnectivity index, strut analysis and star volumes) and fractal dimensions. In addition, two newly important fractal parameters (lacunarity and succolarity) were measured. Compression analysis of the stacks of granules was done. Porosity decreased as the amount of material in the slurry increased but non-linear relationships were observed between microarchitectural parameters describing the pores and porosity. Lacunarity increased in the series of granules but succolarity (reflecting the penetration of a fluid) was maximal in the 15-18g groups and decreased noticeably in the 25g group. The 3-D arrangement of biomaterial granules studied by these new fractal techniques allows the optimal formulation to be derived based on the lowest amount of material, suitable mechanical resistance during crushing and the creation of large interconnected pores.
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