Ex vivo investigations of bioceramic-supported bone regeneration using synchrotron micro-tomography and 3D image analysis

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The current gold standard for bone reconstruction in implant dentistry is the use of autogenous bone grafts. But the concept of guided bone regeneration (GBR) has become a predictable and well-documented surgical approach using biomaterials (bioactive calcium phosphate ceramics) which qualify as bone substitutes for this kind of application as well. We applied high resolution synchrotron micro-tomography (SμCT) and subsequent 3d image analysis in order to investigate bone formation and degradation of the bone substitute material in a three-dimensional manner.
Ideally, a bone substitute material should resorb rapidly, but still stimulate osteogenesis at the same time. Therefore, in order to optimize the biodegradability, the current development focuses on ceramics with higher porosities for applications in GBR. In this study the effect of two particulate graft materials on bone regeneration and expression of osteogenic markers was evaluated in human biopsies sampled 6 months after augmentation of the sinus floor. Additionally, an animal study has been performed in which novel rapidly resorbable bone substitute materials are implanted in sheeps.
The SμCT data complements histologic data of the bone tissue in an ideal manner by yielding highly important information on a) the amount of bone formed in the respective defects and how formation and mineralisation of the regenerated bony tissue progresses in a three-dimensional manner and b) on how the biodegradation of the bone substitute material particles progresses within the regenerated defects.
[1] C. Knabe, C. Koch, A. Rack, M. Stiller, Biomaterials 29, 2249 (2008)
[2] M. Stiller, A. Rack, S. Zabler, J. Goebbels, O. Dalügge, S. Jonscher, C. Knabe, BONE 44, 619 (2009)

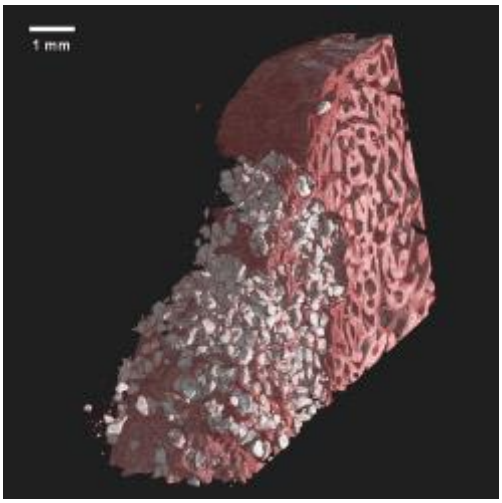

Figure 1: Volume rendering of a SμCT data set (7 μm pixel size) showing ex vivo bioceramic particles in a regenerating sheep mandible.