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Osteoconductive bone substitutes by additive manufacturing

Franz E Weber
University Zurich- Center for Dental Medicine, Switzerland

The current gold standard bone substitute is still autologous bone, despite the fact that its harvest demands for a second operation site, causes additional pain, discomfort, potential destruction of the grafting site, and is limited in supply. Since newly developed clinical approaches like transplantation of cells are invasive and costly, and osteoinduction by bone morphogenetic proteins is expensive and is associated with mild to severe side effects, the optimization of osteoconduction appears as promising option to realize bone substitute based on bone tissue engineering. In the nineties of the last century, the holy grail of pore size for scaffolds in bone tissue engineering was set between 300 and 500 micrometers. These values appeared reasonable since they fall in line with the diameter of osteons. More recently, 2 papers showed that pores even bigger than 1000 micrometers perform equally well. Therefore, the optimal microarchitecture for bone tissue engineering scaffolds in terms of pore size, constrictions, rod thickness, or rod distance is still unknown. Additive manufacturing appears as an ideal tool to study those diverse microarchitecture options since it can generate scaffolds where size and location of pores and connections between pores can repetitively be reproduced. For the production of our test scaffolds, we use the lithography-based additive manufacturing machine CeraFab 7500 from Lithoz (Vienna, Austria) and reach a layer-thickness of 25 micrometres. Moreover, this machine can generate scaffolds from the identical STL-file with different materials ranging from aluminium oxide, to zirconium, to calcium-phosphates and Bioglass. As *in-vivo* test model, we used calvarial defects in rabbits and evaluated calcium-phosphate and Bioglass based scaffolds of diverse microarchitectures. Analysis by μCT and histomorphometry revealed that all generatively produced structures were well osseointegrated into the surrounding bone. The histomorphometric analysis, based solely on the middle section, showed that bone formation was significantly increased in all implant treated groups compared to untreated defects, and confirmed that pores exceeding 500 micrometers are osteoconductive and promote bone regeneration. In the critical size defect, the scaffolds alone were sufficient to yield defect bridging after 16 weeks. Thus, osteoconductive calcium-phosphate based and Bioglass based scaffolds produced by lithography based additive manufacturing are a promising tool for the production of personalized bone tissue engineering scaffolds to be used in cranio-maxillofacial surgery, dentistry, and orthopaedics

Biography

Franz E Weber is currently the Associate Professor in University Zurich- Center for Dental Medicine, Switzerland.

Franz.Weber@zzm.uzh.ch

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