Hydrogel-titanium composites for mandibular reconstruction
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Project #: C-10-37W

Surgeons are in an ongoing search for the ideal solution of bridging larger bony defects in the facial skeleton. In recent years with the advent of microsurgical techniques major strides towards better long term outcomes have been made. The solutions however are a mere manipulation and adaption of bony tissue from another area to more or less fit the requirements. Morbidity and costs are major prohibative factors in this regard. Free bone grafting as an alternative is notoriously unpredictable for larger defects with infection and unpredictable resorption being the predominant culprits. A dire need exists for a custom made, functionable, stable and reliable bone mass that can replace a native mandible or maxilla segment. Pre-planning of future implants is an essential need ensuring adequate future function and quality of life for our patients.
The development of a bone inducing implant for large bone defects composed of an open porous metallic scaffold for primary stability and osteoinductive/osteoconductive hydrogel is proposed. The titanium scaffold derived by rapid prototyping combined with specific surface treatments to allow attachment of bone provides, firstly, the needed mechanical stability to the implant. Secondly, its defined porosity allows the storage of drug-eluting hydrogels facilitating a rapid tissue ingrowth and osseointegration. In the initial phase the designed open pores in the metallic scaffold are used as a containment for provisional matrices and biological cues and later offer sufficient space for vascularisation and bone formation throughout the implant. To avoid stress shielding the majority of the implant will be designed that it mechanically matches cancellous bone. Only a minimum fraction of the implant will be designed to withstand higher mechanical forces in the range of cortical bone.
In this project a broad experience in titanium implants and their production by rapid prototyping provided by the partners from the University of Applied Sciences Northwestern Switzerland is combined with our technologies on extracellular matrices, osteoinductive hydrogels developed over the last decade at the University Hospital Zurich. By the combination of these unique bodies of expertises we will develop novel treatment options for large mandibular defects which are in high need for patients suffering from cancer or other debilitating deseases in the cranio-maxillofacial region.