University of Basel
Department of
Biomedical Engineering

University of Basel, Department of Biomedical Engineering, Gewerbestrasse 14, 4123 Allschwil

Master of Science – Biomedical Engineering
Thesis Proposal

Master Thesis: Minimally invasive implant modules in facial reconstructions

Robot-assisted laser osteotomy allows the separation of bone according to the pre-planned cutting trajectories which is beneficial to corrective or reconstructive bone surgery. This technology has several advantages compared to the conventional method of using a saw. For example, we can precisely cut the bone in pre-defined shapes. This allows us to create interlocking structures to improve the stability between bone and implant interfaces. We are able to connect the cut or "osteotomized" bone accurately with their counterpart in a manner similar to joining together pieces of a puzzle [1]. Additionally, if large bone segments require re-construction, we can divide the large implant into smaller segments which will be joined minimally invasively inside the body, allowing smaller incisions, reduced scarring and a faster recovery of the patient.

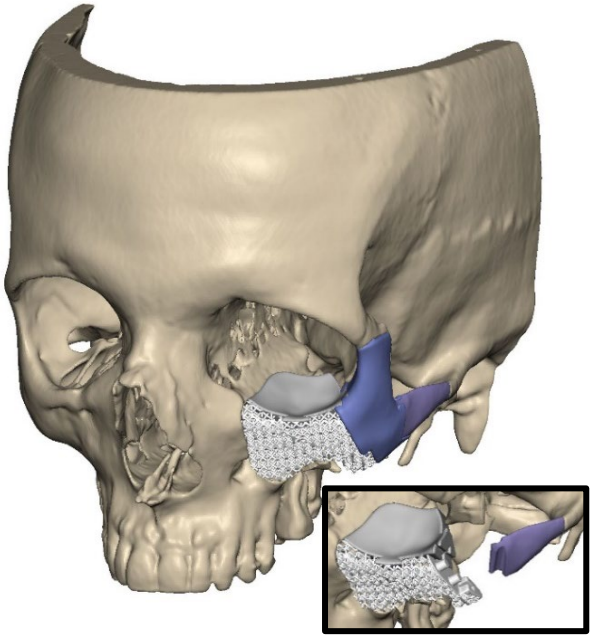

Figure 1 Example of a Zygoma-modular Implant
© MIRACLE Smart Implants HFZ/ Swiss MAM

We believe this innovative concept allows us to create the next generation of "Smart" implants. The aim of this Master Thesis project is to conceptionalize and 3D print various combinations of interlocking structures that are suitable for minimally invasive implantation. A requirement is that they are biomechanically stable under simple and complex load-bearing situations in e.g. maxillomandibular defects. The stability of these implants under biomechanical load should be investigated using Finite Element Analysis and bench testing. If you are interested, please contact us. We are happy to provide more details.

Nature of the Thesis
Experimental: 70%
Programming: 0%
Documentation: 30%

Specific Requirements
- Basic, fundamental knowledge of biomaterials and implants
- Good English skills
- Strong interest in the use of 3D printing for medical applications
- Basic knowledge of 3D printing is advantageous
- Basic knowledge of Finite Element Analysis and biomechanical testing is advantageou

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- Swiss Medical Additive Manufacturing Research Group, Department of Biomedical Engineering, University of Basel
- 3D Print Lab and University Hospital Basel

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Suggested literature/ references:

[1] Stübinger, Stefan, et al., eds. Lasers in oral and maxillofacial surgery. *Springer International Publishing*, 2020.
[2] Palka, Lukasz, et al. "Analysis using the finite element method of a novel modular system of additively manufactured osteofixation plates for mandibular fractures-A preclinical study." *Biomedical Signal Processing and Control* 65 (2021): 102342.
[3] Anabtawi, Mohammed, Mathew Thomas, and Nicholas J. Lee. "The Use of Interlocking Polyetheretherketone (PEEK) Patient-Specific Facial Implants in the Treatment of Facial Deformities. A Retrospective Review of Ten Patients." *Journal of Oral and Maxillofacial Surgery* 79.5 (2021): 1145-e1.
[4] Tikkanen, J., Mesimäki, K., & Snäll, J. (2019). Patient-specific two-piece screwless implant for the reconstruction of a large orbital fracture. *British Journal of Oral and Maxillofacial Surgery*. doi:10.1016/j.bjoms.2019.08.012
[5] Thomas, M., and N. J. Lee. "Interlocking polyetheretherketone implant." *International journal of oral and maxillofacial surgery* 45.8 (2016): 969-970.
[6] Mommaerts, Maurice Y., et al. "Orbital wall reconstruction with two-piece puzzle 3D printed implants." *Craniomaxillofacial trauma & reconstruction* 9.1 (2016): 055-061.
[7] Goodson, M. L., et al. "Use of two-piece polyetheretherketone (PEEK) implants in orbitozygomatic reconstruction." *British Journal of Oral and Maxillofacial Surgery* 50.3 (2012): 268-269.