Universität Basel

Department of Biomedical Engineering

The wound as a 3D print bed

Towards reactive and flexible robotic systems for *in situ* (bio)printing personalized implants

Rubén Martín-Rodríguez[1,2,3], Nicolas Gerig[1], Neha Sharma[2,3], Valentina Basoli[2,3], Florian M. Thieringer[§,2,3], Georg Rauter[§,1]

[1]BIROMED-Lab, Department of Biomedical Engineering, University of Basel, Allschwil, Switzerland
[2]Medical Additive Manufacturing (Swiss MAM) Research Group, Department of Biomedical Engineering, University of Basel, Allschwil, Switzerland
[3]Clinic of Oral and Cranio-Maxillofacial Surgery, University Hospital Basel, Basel, Switzerland
[§]Georg Rauter and Florian M. Thieringer contributed equally to this work as shared last authors.

Bioprinting: conventional vs. *in situ*

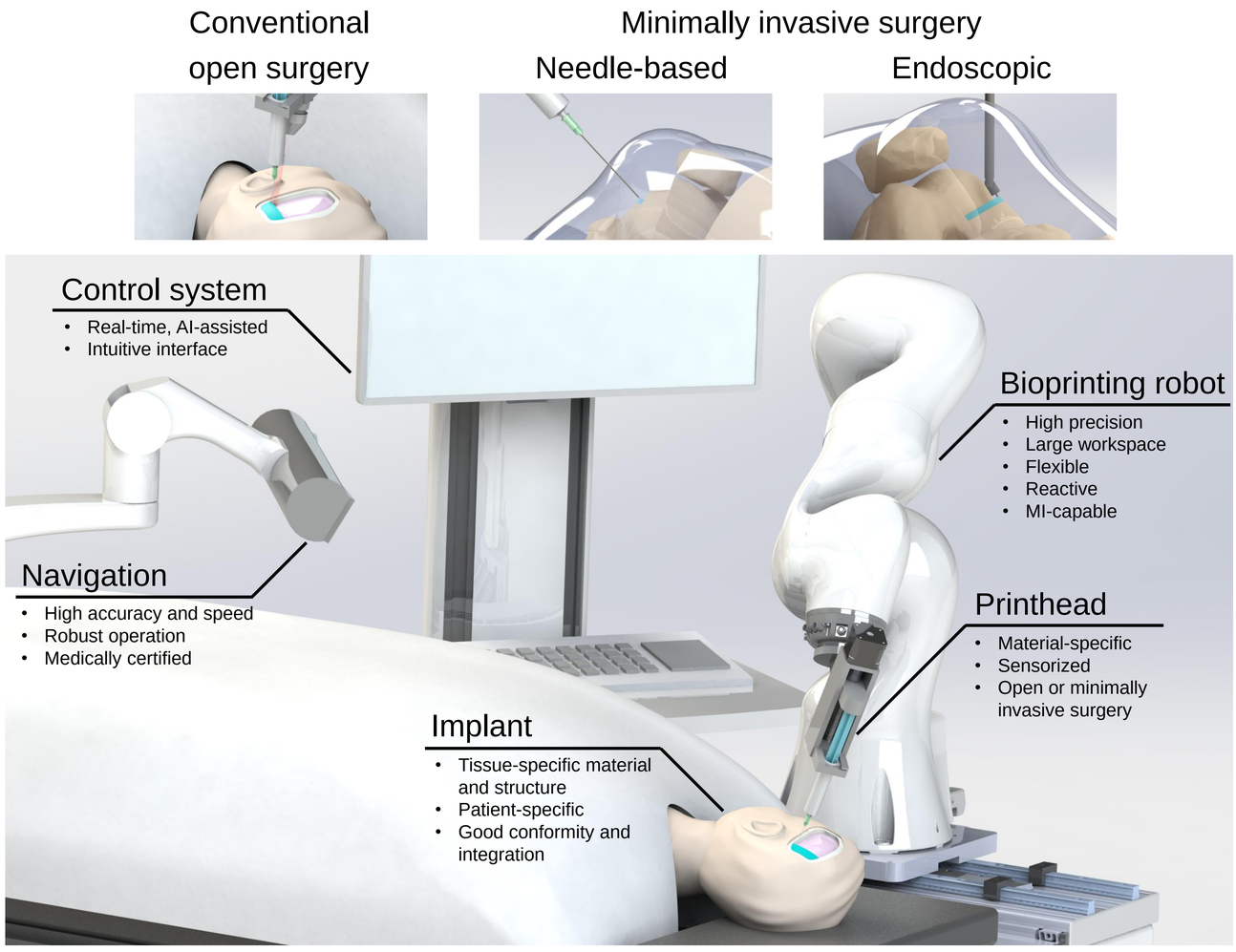
Conventional bioprinting is typically performed by *in vitro* 3D printing, maturation, and implantation.[1]

Robotic *in situ* bioprinting aims to fabricate implants:

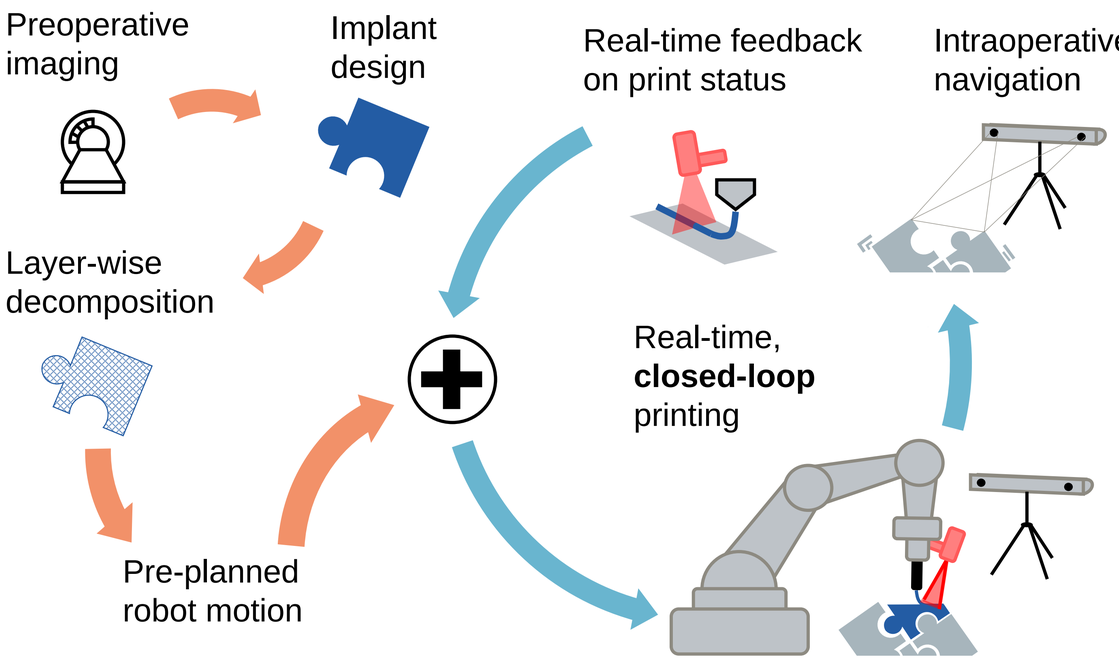
- Directly at the site of the defect [2,3]
- Using robotic systems[2,3]
- Open or minimally invasively[3]

Why bioprinting *in situ*?

- Improved fitting of the implant and adaptation to deviations in surgical planning[2]
- Improved integration with native tissue[3]
- The body acts as the bioreactor for the maturation of the implant[2,3]
- Reduced healing time, risk of infection and damage to native tissue[2,3]



Preoperative planning + intraoperative adaptation



Towards adaptive, closed-loop printing

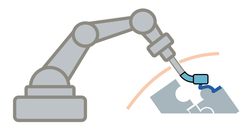
Objective 1: closed-loop platform

Objective 2: minimal invasiveness

Print through a small opening

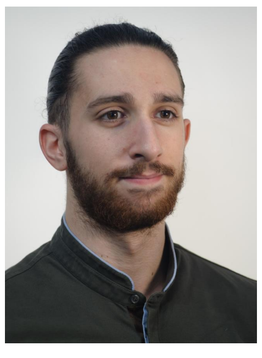
Objective 3: intracorporeal mobility

Robot arm + miniature robots



References

[1] F. Guillemot, V. Mironov, and M. Nakamura, “Bioprinting is coming of age: report from the International Conference on Bioprinting and Biofabrication in Bordeaux (3B’09),” Biofabrication, vol. 2, no. 1, p. 010201, Mar. 2010, doi: 10.1088/1758-5082/2/1/010201.
[2] S. Singh, D. Choudhury, F. Yu, V. Mironov, and M. W. Naing, “In situ bioprinting – Bioprinting from benchside to bedside?,” Acta Biomater., vol. 101, pp. 14–25, Jan. 2020, doi: 10.1016/j.actbio.2019.08.045.
[3] W. Zhao, C. Hu, and T. Xu, “In vivo bioprinting: Broadening the therapeutic horizon for tissue injuries.,” Bioact. Mater., vol. 25, pp. 201–222, Jul. 2023, doi: 10.1016/j.bioactmat.2023.01.018.



BIROMED-Lab

biromed.dbe.unibas.ch

Swiss MAM

swiss-mam.ch

WSS
WERNER SIEMENS-STIFTUNG

MEDICAL ADDITIVE MANUFACTURING
BIROMED-Lab
Universitätsspital Basel
MIRACLE