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Abstract

Development of AI-based segmentation and anatomical reconstruction for orbital floor implants using medical image data

L. Röhrich[1*], S. Eilermann[3], F. Schöfer[1], P. Imgrund[1], P. Gromzig[1], C. Böhm[1], J. Johannsen[1], A. N. Nguyen[1], A. Seibel[1], F. Aavani[2], S. Fuest[2], J. Krösbacher[2], L. Vari[2], I. Kelbassa[1], R. Smeets[2], and O. Niggemann[3]

[1] Fraunhofer Institution for Additive Manufacturing Technologies IAPT, Hamburg, Germany
[2] Department of Oral and Maxillofacial Surgery; University Medical Center Hamburg-Eppendorf, Hamburg, Germany
[3] Faculty of Mechanical Engineering, Helmut Schmidt University, Hamburg, Germany
[*] Corresponding author, email: lotta.roehrich@iapt.fraunhofer.de

Orbital floor fractures are common in craniomaxillofacial trauma, and patient specific implants (PSI) are required to restore the anatomical structure. The current workflow to design the PSI involves manual segmentation of the skull, manual mirroring the healthy orbit to the defected one and manual adapting the implant design to the patient's anatomy. [1] The aim of the work presented here is to automate the process by using AI. The methods used are based on research in the field of cranial implants [2]. The first step involves AI-based preprocessing of the medical image data. For this purpose, a Convolutional Neural Network, the Dense U-Net [3], was trained and used to segment the skull. The next step is the virtual reconstruction of the orbital anatomy. Instead of mirroring, a Statistical Shape Model (SSM) was created. The SSM was based on healthy skulls and its shape can be fitted onto a defected skull. [4] Both process steps were implemented in Python and training runs were conducted. Due to data protection, less than 100 datasets were available for training. In addition, for orbital defects, no image data is available prior to the occurrence of the defect. For this reason, defects were virtually inserted into healthy skull models to test the created SSM. Therefore, more datasets are needed to validate the application in practice.

AUTHOR'S STATEMENT

Conflict of interest: Authors state no conflict of interest. Animal models: Animal models have not been used in the present research. Informed consent: Informed consent has been obtained from all individuals included in this study. Ethical approval: The research related to human use complies with all the relevant national regulations, institutional policies and was performed in accordance with the tenets of the Helsinki Declaration, and has been approved by the authors' institutional review board or equivalent committee.
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REFERENCES

[1] A, Manmadhachary; Mohan A, Aditya; Reddy M, Haranadha (2021): Manufacturing of customized implants for orbital fractures using 3D printing. In: *Bioprinting* 21, e00118. DOI: 10.1016/j.bprint.2020.e00118.
[2] Li, Jianning; Egger, Jan (2020): Towards the Automatization of Cranial Implant Design in Cranioplasty. Cham: Springer International Publishing (12439).
[3] Kolařík, Martin; Burget, Radim; Uher, Václav; Říha, Kamil; Dutta, Malay (2019): Optimized High Resolution 3D Dense-U-Net Network for Brain and Spine Segmentation. In: *Applied Sciences* 9 (3), S. 404. DOI: 10.3390/app9030404.
[4] Li, Jianning; Ellis, David G.; Pepe, Antonio; Gsaxner, Christina; Aizenberg, Michele R.; Kleesiek, Jens; Egger, Jan (2022): Back to the Roots: Reconstructing Large and Complex Cranial Defects using an Image-based Statistical Shape Model. Online verfügbar unter https://arxiv.org/pdf/2204.05703.

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