Burden-Reduced Cleft Lip and Palate Care and Healing

Dr Andreas Mueller (University Hospital Basel, USB) and Dr Barbara Solenthaler (ETH Zurich) combine surgical expertise and 3D morphometric know-how in this impactful project aimed to simplify and optimise the postnatal care and surgical treatment of cleft lip and palate in young children.

With the use of machine learning algorithms, smartphone-based images of the palate malformation, and 3D printing of tailor-made palatal orthopaedic plates, this project will potentially revolutionise the standard course of treatment of cleft lip and palate. This project aims to reduce the burden of surgery from a multi-step to a single-step procedure by leveraging cutting-edge technology. The applicability of the proposed research project is especially relevant for children in low-income settings because current treatments are relatively high in cost and burdensome for the young patients and their parents, who, in addition, may also face challenges in securing the funding for the multiple surgeries presently needed. The project goals also ease the social integration of children with cleft lip and palate.

The motivation for this project is the recognition that orofacial clefts are the most frequent craniofacial malformation (1:700 births). No effective preventive measures exist. The focus is on an optimal treatment strategy with minimal burden for the patient and healthcare system. Currently, two principles are used and commonly applied complementary: (1) a palatal plate therapy after birth to keep the tongue out of the cleft space and to narrow the palatal cleft and (2) a multi-step surgical repair. However, this strategy necessitates a palatal impression that endangers the child’s airway and a high surgical burden. The project therefore develops a non-invasive strategy for the palatal plate therapy followed by a one-step surgical repair of the entire cleft lip and palate malformation.

The methods rely on data-driven algorithms to digitally reconstruct the palatal shape in 3D from intraoral photographs. The model-based reconstruction approach will be integrated into photogrammetric setups. In addition, a neural network will be trained to predict/regress the 3D geometry from a single palatal image. To support the data-driven algorithm, a database from images and corresponding plaster casts from palatal impressions are available from USB. The 3D printing of palatal plates and surgical method for one-step surgical repair are already in clinical use at USB and its partner clinic in Warsaw, Poland. Thus, the novel treatment regimen will be ready for clinical use and scalability directly after successful development of the innovation.

The MIP project will build upon established success of the pilot work to develop a groundbreaking new cleft lip and palate treatment regime that focuses on three aims:

1. Non-invasive, data-driven 3D palatal shape reconstruction from images
2. Automated palatal plate design and manufacturing with 3D printing
3. One single surgical intervention

In addition to the principal investigators Dr Andreas Mueller and Dr Barbara Solenthaler, a number of partners will contribute to the success of the project with their strong expertise. Dr Gosia Reddy from GSR Institute of Craniofacial Surgery, Hyderabad, India, will further enhance clinical implementation and cover specific characteristics in the healthcare systems of LMICs. Dr Andrzej Brudnicki from the Institute of Mother and Child, Warsaw, and Cleft Lip and Palate Clinic Formmed, Warsaw, brings perspective and input from the world’s largest cleft centre using single-surgery cleft repair. Prof Markus Gross from Disney Research brings the latest aspects and knowledge of digital face reconstruction and photo-realistic rendering.

Digital image data capture and collection, 3D printing of orthopaedic palatal plate and shift from multi- to one-step surgical repair will potentially revolutionize the standard course of treatment of cleft lip and palate.