Interactive Planning of Miniplates

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INTRODUCTION

In this contribution, a novel method for computer aided surgery planning of facial defects by using models of purchasable MedArtis Modus 2.0 miniplates is proposed. Implants of this kind, which belong to the osteosynthetic material, are commonly used for treating defects in the facial area. By placing them perpendicular on the defect, the miniplates are fixed on the healthy bone, bent with respect to the surface, to stabilize the defective area (Figure 1). Our software is able to fit a selection of the most common implant models to the surgeon's desired position in a 3D computer model. The fitting respects the local surface curvature and adjusts direction and position in any desired way.

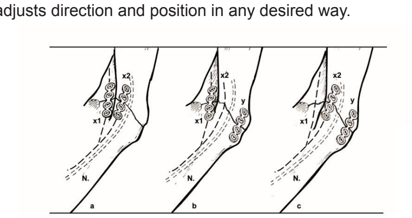

Fig. 1 Clinically used osteosynthesis of the left mandibular angle using two plate techniques. X1, x2 plate position, N: Inferior alveolar nerve in the mandibular bone. Note: The nerve does not interfere with the bone plates to avoid nerve damaging and loss of lip sensibility.

Reconstructing facial deformations due to bone fractures or born deformations is the daily routine of a surgeon. Causes of bone fractures are outer forces, such as from a car accident, removed tumors or deformation treatment. All those operations (osteosynthesis) have in common that they use so-called miniplates (Figure 2).

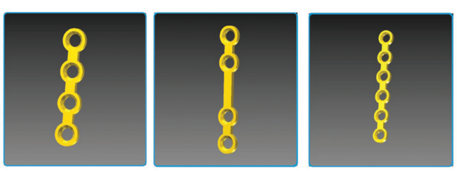

Fig. 2 The three figures show commonly available miniplates for bone fracture fixation. All models are of the MedArtis Trauma 2.0 series.

METHODS

The software application was developed using the medical imaging and visualization platform MeVisLab, which provides an interface for connecting existing and new, proprietary algorithms using a dataflow network. Figure 3 shows a flow chart overview of the software. The user loads the dataset (Load Data Set), defines the implant's center position (Set Initial Point) and orientation (Mouse Wheel) and chooses the implant type (Model Selection). With this information, we calculate the centerline (Baseline Calculation), subsequently used as a proxy for fast display during interaction (Viewer). The baseline position and orientation can be changed by the user with direct manipulation. If the user is satisfied, the full-resolution implant is generated ring by ring (End Ring Section and Middle Ring Section), followed by generating the connecting bridge parts (Implant Generation).

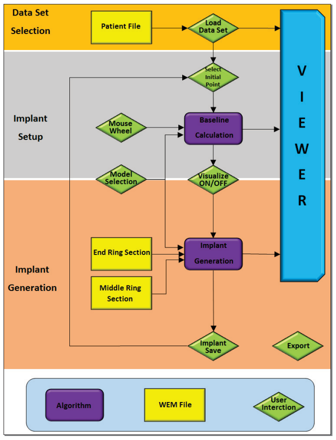

Fig. 3 Flow chart of the proposed application, starting with loading the patient data set and ending with saving / export the patient-specific designed implant for further usage, like 3D printing. Overall, the flow chart is divided in three main sections: Data Set Selection, Implant Setup and Implant Generation.

After the implant / miniplate has been created, it can be saved for later usage (Implant Save) or converted to the STereoLithography (STL) format for 3D printing (Export).

RESULTS

In this contribution, the interactive planning of facial fracture treatment using common miniplates has been presented (Figure 4). The end user loads a clinical data set and interactively chooses the location of the implant on the bone structure. Depending on the selected implant model, a proxy derived from the miniplate baseline shows necessary properties for a correct placement.

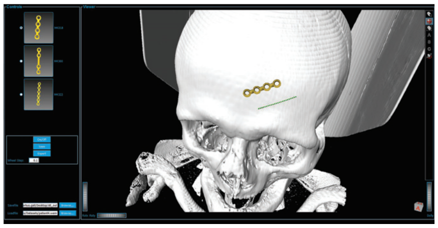

Fig. 4 User interface

CONCLUSIONS

1. **The successful interactive planning and reconstruction of facial 3D implants;**
2. **A precise capture of the surface curvature as a basis for several types of implants;**
3. **Flexibility in model types as well as in positioning and orientating the miniplates;**
4. **Evaluation with real patient Computed Tomography (CT) data from the clinical routine;**
5. **Enabling 3D implant export as Computer-Aided Design (CAD) file format for 3D printing and in-depth pre-surgical assessment;**
6. **Providing clinical datasets and source code to the research community for own usage.**

There are several areas for future work, like supporting more implant types up to personalized ones and bone segmentation, and repositioning.

REFERENCES

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The work received funding from BioTechMed-Graz ("Hardware accelerated intelligent medical imaging") and the 6th Call of the Initial Funding Program from the Research & Technology House (F&T-Haus) at the Graz University of Technology ("Interactive Planning and Reconstruction of Facial Defects", PI: Dr. Dr. Jan Egger). Dr. Xiaojun Chen receives support by the Natural Science Foundation of China (Grant No.: 81511130089) and the Foundation of Science and Technology Commission of Shanghai Municipality (Grants No.: 14441901002, 15510722200 and 16441908400). A video of the interactive planning can be found under the following YouTube link: https://www.youtube.com/c/JanEgger/videos