Innovations in Maxillofacial Surgery: Guided Maxillofacial Surgery

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The precise realization of osteotomies and exact positioning of skeletal parts released by osteotomy maneuvers can be concerns for maxillofacial surgeons. Guided maxillofacial surgery represents one of the latest innovations in maxillofacial surgery and consists of simulating a computer osteotomy to ensure accurate three-dimensional positioning of intraoperative bone cutting and precise drill guides created through the use of miniplates that have been manufactured before surgery with commercially pure porous titanium (CPTI) under direct metal laser sintering (DMLS).

The size and shape of these pre-fabricated miniplates will match exactly to the anatomy of the skeletal parts released by osteotomy maneuvers and the spaces created by the respective movement of skeletal fragments. The surgeon can dispose good model miniplates immediately. The joining of these miniplates also eliminates any intraoperative bending that can occur in miniplates and promote precise positioning of the skeletal parts.

After creating the computer simulation of the planned osteotomy by the surgeon, the DICOM data of the simulation is sent to the biomedical engineer who then draws the prototype of the osteotomy guide based on the recommendations of the surgeon. The stability of the osteotomy guide on the maxilla is determined by its close contact with the underlying skeleton and this can be augmented by the placement of mini-screws. The design of the osteotomy guide must ascertain the precise execution of the LeFort I osteotomy. Once the design of the osteotomy guide is validated by the surgeon, it is produced using sinterable polyamide by stereolithography. (Fig. 1)

The design of the custom-made titanium miniplate system completed by the biomedical engineer takes into consideration multiple factors, in particular, the size and form of the system. The miniplate system must lie on the maxilla in a completely passive fashion, without transmitting any tension or trauma to the underlying skeleton. These custom-made miniplates are created as a single unit, initially joined together to allow for their use as a positioning guide. The use of this guide permits maximal congruence and contact between the bony segments and the miniplates themselves and thus enables the precise positioning of the skeletal segments freed by the osteotomy. The miniplates are joined together either in 4 by 4 configuration (LeFort I osteotomy) or in 2 by 2 configuration (sagittal split, genioplasty). The positioning and depth of the miniplates for osteosynthesis are also simulated. (Fig. 2)

This new system of custom-made titanium miniplates (either 4 by 4 or the 2 by 2) functions intrinsically as a positioning guide and allows for precise positioning and rapid fixation of the maxillary or mandibular segments.

This new miniplate system also has several other advantages. - It serves as an ideal drill guide as it takes into account the specific anatomy of the patient. During virtual surgery planning, the length of the screws and their best position of placement can be ascertained in function to the thickness and density of the underlying bone.

- It decreases the length of time needed for the surgical procedure.

- It decreases any associated trauma to the underlying skeletal structure as it is made in accordance with the individual anatomy of the patient and the desired skeletal displacement of the bony segments.

- It makes the operation much easier for the surgeon and decreases the time spent in the operating room.

Guided maxillofacial surgery is mainly discussed in orthognathic surgery and implant surgery (LeFort 1 indicated for maxillary acquired atrophy) but other applications can also benefit from guided surgery:

- In patients who have unilateral deformities, the final result of the facial bone reduction and fixation can be based on the contralateral normal skeleton. In this situation, the miniplate system can be designed based upon a contralateral face by symmetrising digitally from the midline.

- All cranio-maxillofacial osteotomies or maxillofacial reconstructions may benefit from this new type of custom-fit miniplate osteosynthesis.

References

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