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ON SITE 3D PRINTING IN ORAL AND MAXILLOFACIAL SURGERY

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However the progress in 3D printing for medical purposes has improved on commercially based services and the development of 3D printing devices is decreasing; there are challenges for increase the quality of printing techniques for biomedical purposes. The aim of this project was to evaluate the limits and possibilities of different non-commercial on site 3D printing devices for instant model and templates production.

In oral and maxillofacial surgery standard protocols for 3D CAD/CAM production of patient specific implants, surgical templates and others are becoming frequently used. In some instances not only the high pricing and time delay in production is a problem which should be solved with on-site 3D printers. A test template for comparing the accuracy and parameters of different printing techniques was used.

METHODS

Based on CT scans a SW 3D reconstruction is performed, in cases of unilateral involvement a mirroring is used to reconstruct the missing structure pattern. Realignment of the reconstruction to the original structures was made. The final step was 3D print of the required 3D structure, to be used for patient specific implant fabrication or just simple implant premolding before entering the operating theater. This method enables to create exact models of even the smallest anatomical structures.

CASE REPORT

A patient presented to the faculty hospital in Pilsen with severely displaced and defective orbital fracture to the left face. Based on medical imaging of computed tomography (Fig. 1), the 3D reconstruction image reveals the severity of fragment displacement. The missing structures of the lateral orbital wall and zygomatic bone was created by mirroring the contralateral side using the open source Meshmixer SW (Fig. 2). For the production of a sterelolithographic model using a Formlabs Photopolymerysitation 3D printer used, firstly the model alignment and suport post were created (Fig. 3). The manufactured

final model (Fig. 4) was used as a preoperative tool to perform the proper pattern of reconstructive Titanium mesh for maintaining precise perioperative fragment reduction (Fig. 5). However the surgical intervention was performed by simple plates (Fig. 6) because there was a possibility to realign all fragments precisely, the 3D template was used to bend any plate to the necessary shape. The final post-operative result in 3D CT reconstruction,

Fig 1 Patient with defective orbital fracture

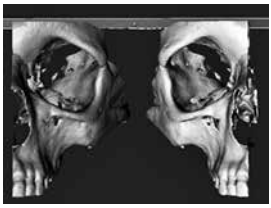

Fig 2 Reconstruction by mirroring the contralateral side (MeshMixer SW)

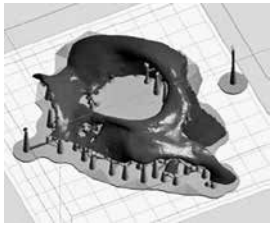

Fig 3 Plan for production of sterelolithographic model (Formlabs Printer)

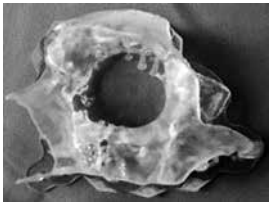

Fig 4 Sterelolithographic model produced from photopolymer

Fig 5 3D preshaped mesh for orbital reconstruction

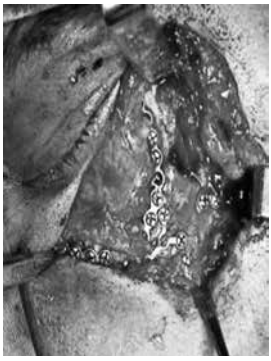

Fig 6 Orbital reconstruction surgery

Fig 7 Postoperative image showing restoration of orbital contour

showed adequate reduction of facial contours (Fig. 7). 3D virtual planning is a useful tool for preoperative and perioperative hardware adaptation for orbital reconstruction in order to re-create patient's pre-injury bony contour, adequate facial symmetry, functional and aesthetic results. Moreover, it can be used as a communication tool for explanation of surgery to patient and for educational purpose as well.

FINDINGS AND CONCLUSIONS

It is feasible to produce high quality templates for patient specific implant by using simple and open source SW tools. The overall easy access to 3D printers makes it possible to produce sufficient hardcopy templates as tools for reconstruction of bones in maxillofacial surgery within few hours on a reasonable price level. This can improve the quality of bone reconstruction surgeries. The use of 3-D models has proven to greatly decrease surgical operating time, decrease time under general anesthesia, and decrease wound exposure time. The regulations for Patient specific implants production in different countries must be respected.

SUMMARY

Nowadays 3D printing for biomedical purpose is effective method to improve not only the quality of the produced model, but price reduction as well. In past 3 years, we tried different 3D printing technics for use in Maxillofacial Surgey mainly for pre-operative planning and re-shaping of Osseosyntetic materials. This article discusses the use of available SW and 3D printing to create model for surgical reconstruction of defective / missing orbital structures.

Využití 3D tisku v maxilofaciální chirurgii

SOUHRN

Využití 3D tisku pro biomedicínské aplikace se stává dostupnou a efektivní metodou nejen v souvislosti se snižující se cenou, dostupností 3D tiskáren, ale také se zvyšuje kvalita produkovaných modelů. V uplynulých 3 letech jsme testovali různé 3D tiskové techniky pro využití v maxilofaciální chirurgii, zejména pro předoperační plánování a přetvarování osteosyntetického materiálu. Příspěvek dokumentuje použití volně dostupných SW prostředků a vlastní 3D tiskárny pro vytvoření modelu chybějících struktur očnice pro rekonstrukční chirurgický výkon.

REFERENCES

1. Pushkar Mehra, Jeremey Miner, Richard D'Innocenzo, Mohammed Nadershah: Use of 3-D Stereolithographic Models in Oral and Maxillofacial Surgery. J. Maxillofac. Oral Surg. 10 (1), 2011: 6–13. – 2. Chow L., Cheung L.: The usefulness of stereomodels in maxillofacial surgical management. J. Oral Maxillofac. Surg. 65, 2007: 2260–2268. – 3. Schicho K., Figl M., Seemann R. et al.: Accuracy of treatment planning based on stereolithography in computer assisted surgery. Med. Phys. 33 (9), 2006: 3408–3417.

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