Oral Surgery **Case Report**
International Journal of Clinical And Diagnostic Research **ISSN 2395-3403**
Volume 6, Issue 4 , July-Aug 2018

DETAILING THE SOFTWARE AIDED DESIGNING OF 3-D MODEL FOR MANDIBULAR RECONSTRUCTION: A CASE REPORT

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Abstract

The concept of using 3-D models in the field of oral and maxillofacial surgery is not new. On 8 August 1984, Charles W 'Chuck' Hull got the patent for creating an apparatus that creates 3-D replicas. It took 10 more years to get it implemented in the field of medicine and surgery. Now this technology is being used by surgeons all over the world. In this paper, we are sharing our experience of designing a part of mandible where a resected part of the mandible (afflicted with recurrent amelobastoma) is removed and reconstructed with autogenous bone grafts like free fibula flap.

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Keywords: 3-D models, designing, free fibula, reconstruction

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INTRODUCTION

Reconstruction is an art and challenge for the maxillofacial surgeons as it demands esthetics, stability and function. Even though there are multiple options for reconstruction, autogenous bone grafts are considered as reliable and standard option [1]. Reconstruction of mandible by using vascularised bone grafts procedures can be considerably optimized with the use of 3-dimensional anatomic models. Unlike conventional CT images in which the surgeon should interact with images on a film or a monitor, it is possible to handle the entire surgical area using the 3D models, making it easier to perform surgical planning [2]. In this paper, we present a case to demonstrate the use of 3-D printing technology in mandibular reconstruction using free fibula flap, with special emphasis on the use of designing software.

CASE REPORT

A 27-year-old female reported with a swelling in relation to right cheek region for 6 months (Fig1). History reveals that she had undergone surgical removal of similar lesion on the same side 2 years back. Histopathology report of previous lesion showed that it was ameloblastoma. We suspected its recurrence and planned for investigations. Panoramic radiograph and CT revealed that excised region of the mandible was supported by a reconstruction plate and the lesion was more of soft tissue in origin. We did an incision biopsy and the result showed that it was ameloblastoma. We planned for excision of affected part of the mandible under general anesthesia and reconstruct it with a free fibula flap. But the ideal problem for reconstruction was to sculpt the fibula into the shape of the lost mandible. For that we decided to explore the 3-D printing technology.

Figure 1: Figure showing recurrent swelling in relation to right mandibular region

DESIGNING

FIRST STAGE FABRICATION:

CT imaging was performed on a 64-slice multidetector CT scanner. Volumetric data in DICOM (Digital Imaging and Communications in Medicine) was acquired (1 mm slice thickness, 0.5 mm increment).

These DICOM files were opened in third party software called Invesalius 3.0(developed by Renato Archer Information Technology Center). All such CT images were compiled into a single virtual 3-D image of the patient's facial bones. This 3-D virtual image was saved in a OBJ (object file) format (fig. 2).

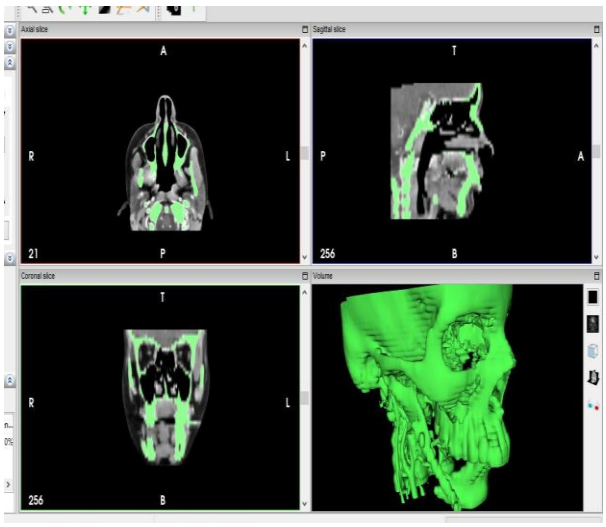

Figure 2: Virtual 3D image generated

This saved file was converted to STL (stereolithography) format which is the machine recognizable format which is ready for printing. The conversion of OBJ files to STL format was done on software called Meshmixer 3.2(Autodesk). Meshmixer is a designing type of software which can be used for editing virtual 3D models before printing. The inputs in the form of STL format given to the printer (Ultimaker 2) ultimately produce a beautiful anatomical model of the patients' facial bones (fig. 3)

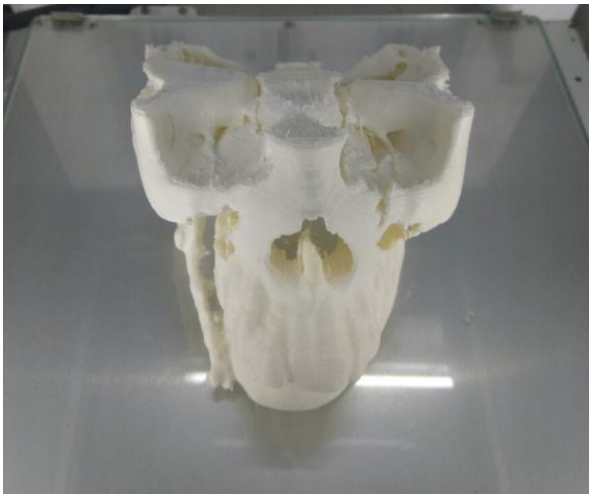

Figure 3: Printed anatomical model using PLA

SECOND STAGE FABRICATION:

In the second stage we planned for creating the 'mirror image' of the normal side of the mandible and to print it. The mirror image was created using the Meshmixer 3.2 (Autodesk) software. The whole stages of designing were completed in less than ten minutes. After refining the surfaces of the design in the software, the mirror image of the normal half of the mandible got printed using the poly lactic acid material (fig 4).

On the anatomical model, the planned mandibular surfaces were removed and we sculpted the printed mirror image of the normal mandible as a template and made it fit into the resected region in the model. We measured the dimensions of the template and

depicted it in the harvested fibula and reconstructed the area.

Figure 4: Printed model of mirror image of the normal side

DISCUSSION

Mandibular defects are caused due to many reasons including tumors, infections such as osteomyelitis, osteoradionecrosis and even trauma. Commonly used reliable alloplastic reconstructive options include titanium reconstruction plates. But it is temporary and it is only a metallic connection [3]. Autogenous bone graft is a gold standard for functional rehabilitation of the mandible [4]. Free fibula is used as extensively as an autogenous option [5, 6]. The challenge of reconstruction is to superimpose the size and the shape of the defect area into the donor bone. Templates made from the 3-D anatomical models single-handedly perform this task. Many authors use different softwares for the designing purposes, which is based on the availability and the type of machine used for scanning [1]. The softwares used for our procedures were very simple and reliable. Availability of various plastics for creating 3-D models is described in the literature which includes, ABS (Acrylonitrile butadiene styrene), PVC, nylon, PLA (Polylactic Acid) etc [7]. Printer used for our procedure was based on fused deposition modelling technology that uses PLA as printing material as well as support material. PLA has got average tensile strength of 56.6 Mpa and elastic moduli of 3368 Mpa, [8] which was enough for our purpose. But the melting temperature of PLA was less compared to ABS which made it difficult for cutting using regular burs [8]. As we did not use smoothening agent dichloromethane for improving the surface texture of the model, the printed surface was rough.

CONCLUSION

As compared to our previous maxillofacial surgeries done without 3-D models, precision of the size and shape of the graft was improved and the time of surgery was reduced in this case. The technology of additive printed anatomical models is now becoming an aid for surgical planning. Its applications are limitless and its effects are always superior.

Conflict of Interest Statement-

There is no conflict of interest.

REFERENCES:

1. Cohen A, Laviv A, Berman P, Nashef R, Abu-Tair J. Mandibular reconstruction using stereolithographic 3-dimensional printing modeling technology. Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology. 2009 Nov 30; 108(5):661-6.
2. Erickson DM, Chance D, Schmitt S, Mathis J. An opinion survey of reported benefits from the use of stereolithographic models. J Oral Maxillofac Surg. 1999; 57:1040-3.
3. Bee TG, Shermin L, Henk T, Paul JW.Mandibular reconstruction in adults: a review. Int J Oral Maxillofac Surg. 2008; 37:597-605.
4. Pogrel MA, Podlesh S, Anthony JP, Alexander J. A comparison of vascularised and nonvascularized bone grafts for reconstruction of mandibular continuity defects. J Oral Maxillofac Surg. 1997; 55:1200-6.
5. Chana JS, Chang YM, Wei FC, Shen YF, Chan CP, Lin HN, et al. Segmental mandibulectomy and immediate free fibula osteoseptocutaneous flap reconstruction with endosteal implants: an ideal treatment method for mandibular ameloblastoma. Plast Reconstr Surg. 2004; 113:80-7.
6. Chang YM, Shen YF, Lin HN, Tsai AH, Tsai CY, Wei FC. Total reconstruction and rehabilitation with vascularized fibula graft and osseointegrated teeth implantation after segmental mandibulectomy for fibrous dysplasia. Plast Reconstr Surg. 2004; 113 1205-8.
7. Chia HN, Wu BM. Recent advances in 3D printing of biomaterials. Journal of biological engineering. 2015; 9(1):4.
8. Tymrak BM, Kreiger M, Pearce JM. Mechanical properties of components fabricated with open-source 3-D printers under realistic environmental conditions. Materials & Design. 2014; 30: 58:242-6.