# Section: Dentistry

# Rehabilitation of a Patient of Traumatic Anotia using Computer Aided Designing and Rapid Prototyping

# Maj Abir Sarkar<sup>1</sup>, Maj Pramod Chahar<sup>2</sup>, Brig E Mahesh Gowda<sup>3</sup>, Lt Col Poonam Prakash<sup>4</sup>

## ABSTRACT

**Introduction:** Absence of external auricle predisposes an individual to a great deal of psychological trauma along with functional complications. The conventional methods of fabrication of auricular prosthesis by duplicating the morphology of the normal contralateral ear are time consuming, error-prone and very much subjective in terms of quality.

**Case report:** The present case report describes rehabilitation of a patient of traumatic anotia of left side with a custom made adhesive retained silicone prosthesis, developed with the help of computer aided designing and rapid prototyping technology.

**Conclusion:** Consistent good quality prosthesis may be obtained using advanced digital technologies that include optical scanning, computer-aided designing (CAD) and rapid prototyping (RP) which are more objective in nature.

**Keywords:** Auricular Prosthesis, Maxillofacial Prosthesis, Traumatic Anotia, CAD/CAM, Rapid Prototyping, RP, Optical Scanner, Fused Deposition Modelling.

# **INTRODUCTION**

External auricle, by virtue of its critical position in the facial anatomy, plays a vital role providing symmetry and beauty to the face. Absence of external auricle predisposes an individual to a great deal of psychological trauma along with functional complications. Rehabilitation of these maxillofacial defects have been a challenge to the prosthodontists. Since the first documented case of auricular prosthesis by Ambroise Pare (1510-1590), the fabrication process has come a long way successfully rehabilitating patients with missing external auricle.<sup>1</sup> The morphology of the prosthesis is created by matching with the morphology of the normal contralateral ear. This morphology is currently obtained by one of the following methods: (i) producing a cast of the patient's contralateral ear by direct impression and sculpting a mirror pattern corresponding to the missing ear; (ii) producing a cast using the ear of a family member or an individual with compatible ear morphology and using it for producing the ear prosthesis; (iii) producing a cast of the patient's contralateral normal ear and creating its photo image on a transparent sheet (viewing the image from the reverse side gives the morphology of the ear prosthesis to be sculpted)<sup>2</sup>; or (iv) making a wax cast of the contralateral normal ear of the patient, sectioning the cast into 1-mm slices and reversing the sections to create a mirrored pattern.<sup>3</sup> The final outcome in terms of morphological reproduction is highly subjective depending on the skills of prosthodontist, anaplastologist or laboratory technicians involved. The conventional methods of fabrication of auricular prosthesis require experience, take considerable time and are error-prone.<sup>4</sup> Consistent good quality prosthesis may be achieved using advanced digital technologies that include optical scanning, computer-aided designing (CAD) and rapid prototyping (RP) which are more objective in nature.

The present case report describes rehabilitation of a patient of traumatic anotia of left side with a custom made adhesive retained silicone prosthesis, developed with the help of computer aided manufacturing and rapid prototyping technology.

# **CASE REPORT**

A 22 years old male patient reported to the Division of Prosthodontics with the chief complaint of missing left ear. According to the history provided by the patient, he lost the ear subsequent to a road traffic accident (RTA) one and half years ago in which the left ear and adjoining areas of face were severely mutilated. He subsequently underwent multiple surgeries that has left a residual anotia defect.

On extra oral examination, the left external auricle was found to be missing but the left tragus was seen to be intact. Superficial skin around the missing auricle showed diffuse scarring involving temple and pre auricular region upto the mandibular angle. Hairline was also noted to be shifted upwards due to the scar. The external auditory meatus was present and audiometric evaluation showed the patient had

<sup>1</sup>PG Resident, Division of Prosthodontics and Crown and Bridge, Department of Dental Surgery and Oral Health Sciences, Armed Forces Medical College, Pune, <sup>2</sup>PG Resident, Division of Prosthodontics and Crown and Bridge, Department of Dental Surgery and Oral Health Sciences, Armed Forces Medical College. Pune, <sup>3</sup>Associate Professor, Division of Prosthodontics and Crown and Bridge, Department of Dental Surgery and Oral Health Sciences, Armed Forces Medical College. Pune, <sup>4</sup>Assistant Professor, Division of Prosthodontics and Crown and Bridge, Department of Dental Surgery and Oral Health Sciences, Armed Forces Medical College. Pune, India

**Corresponding author:** Maj Abir Sarkar, PG Resident, Division of Prosthodontics and Crown and Bridge, Department of Dental Surgery and Oral Health Sciences, Armed Forces Medical College. Pune, India

**How to cite this article:** Maj Abir Sarkar, Maj Pramod Chahar, Brig E Mahesh Gowda, Lt Col Poonam Prakash. Rehabilitation of a patient of traumatic anotia using computer aided designing and rapid prototyping. International Journal of Contemporary Medical Research 2019;6(1):A18-A21.

DOI: http://dx.doi.org/10.21276/ijcmr.2019.6.1.35



Figure-1: Pretreatment, Anotia involving left external ear



Figure-2: Optical impression and digital model creation



Figure-3: Computer aided designing



Figure-6: Wax pattern try in



Figure-7: There piece mould



Figure-8: Laboratory processing



Figure-4: FDM Printer



Figure-5: ABS prototype and wax pattern

normal hearing abilities. Based on the history and clinical evaluation, a diagnosis of residual anotia defect of left side

Figure-9: Prosthesis in situ

secondary to RTA was made. An adhesive retained room temperature vulcanising silicone auricular prosthesis was planned to rehabilitate the patient. The treatment plan was discussed with the patient and an informed written consent was obtained.

# **Optical impression and Computer Aided Designing**

An optical impression of the face was made using Artec Space Spider surface scanner (Artec 3D, Luxembourg) and subsequent 3D reconstruction done using indigenously developed computer aided designing software Osto3D Section: Dentistry

(COEP, Pune, India). Using the 3D reconstructed optical scan data the normal right auricle was sliced into 1 mm sections and the slices were reverse stacked. Subsequently a mirror image was produced mimicking the lost external auricle in the CAD software. The resultant 3D Image was superimposed on the left side and blended to match the morphology.

## Prototype production and duplication

Newly developed virtual left auricle was extracted in '.stl' format to be 3D printed using an Fused Deposition Modelling printer and subsequently a prototype model of the intended left auricle was obtained in Acrylonitrile Butadiene Styrene (ABS) resin.

The model was duplicated in polyvinyl siloxane duplicating material (Elite double 22, Zhermack) and wax was poured into it to obtain a wax pattern of the missing auricle.

#### Pattern try in and processing

The wax pattern was tried on the patient for its location, orientation and projection and written approval was obtained from the patient and close relatives. It was invested to fabricate a three piece mould. Room temperature vulcanizing silicones (MP Sai, MP SAI BIOMED, Mumbai) was packed after proper base shade matching and intrinsic staining. After curing the prosthesis as retrieved and characterisation was achieved by extrinsic pigments to exactly match the shade and texture of the patients opposing ear. The prosthesis was retained with the help of a medical grade adhesive (Medical adhesive, Hollister) and necessary post insertion instructions were prescribed to the patient.

## DISCUSSION

Rapid Prototyping is a process that creates parts in an additive, layer-by-layer manner. It is a special class of machine technology that quickly produces models and prototype parts from 3D data using an additive approach to form the physical models. Rapid prototyping (RP) is a relatively new class of technology used for building physical models and prototype parts from 3D CAD data. It was developed by Chuck Hull of 3D Systems of Valencia, CA, USA in 1984.<sup>5</sup>

3D printing or rapid prototyping techniques have been employed effectively for fabrication of facial prosthesis over the past decade.<sup>6</sup> The key idea of this innovative method is that the three dimensional CAD (3D-CAD) model is sliced into many thin layers and the manufacturing equipment uses this geometric data to build each layer sequentially until the part is completed. This technology can yield complex shapes with cavities and undercuts; frequently the case in human anatomy structures.<sup>7</sup>

An optical scanner makes no physical contact with the tissues while exactly recording its undistorted anatomy, considered to be a distinct advantage over the conventional impression procedure. CAD software exactly replicates the anatomy of patients normal ear by creating a mirror image pattern of the same using the scan data<sup>3</sup> making the procedure highly objective, individualistic and accurate.

Fused deposition modelling (FDM) is a form of 3D printing

technology developed by S. Scott Crump in the late 1980 and later commercialised in 1990 by Stratasys. In this form of printer a filament of material is extruded out of a fine nozzle and deposited onto a platform. The nozzle moves in the X-Y plane so that the filament is laid down to form a thin cross-sectional slice of the part. The platform is then lowered relative to the nozzle and the next slice of the part is deposited on top of the previous slice. As the extruded filament is hot, it bonds to the material in the previous slice.<sup>8</sup> At present there are four options through which RP can be applied in Maxillofacial prosthesis<sup>9</sup>:

- Prototype development
- Direct wax pattern development
- Direct negative mold fabrication and silicone packing
- Direct 3D printed prosthesis fabrication

In the case report discussed, the first option has been utilised. After the 3D model fabrication through FDM, it was duplicated and a wax pattern has been developed. Subsequently the wax pattern was processed in a conventional manner. In this particular approach the tissue distortion while making a conventional impression has been nullified with the use of optical surface scanner. More over time consuming and highly arbitrary wax pattern sculpting steps have also been avoided with the computer aided designing process. These modifications have enabled the generation of a highly accurate and individualistic prosthesis using a unique combination of contemporary and existing conventional workflow thereby saving additional expense.

The involvement of technology has made the process of fabrication more scientific, individualistic and time saving. More over the 3D printed mould and the CAD data can be used subsequently to fabricate a new prosthesis in the event of loss or physical damage of the fabricated prosthesis hence reducing time, manual effort and inconvenience to the patient in the long run. The stored 3D reconstruction data can also be used to form a digital library which may be beneficial to other patient.

# CONCLUSION

With the introduction of CAD and RP technologies in the dental practice, particularly in maxillofacial prosthetics which encompasses highly variable and complex anatomical structures, the benefits have been phenomenal. However, the limitations of the RP technology include the high cost and limited availability and associated technological operational expertise. With the continuous technological advancements and development of user friendly CAD softwares, these procedures will soon become an integral part of the regular prosthodontic workflow.

#### REFERENCES

- Beumer J, Curtis TA, Marunick MT. Maxillofacial rehabilitation: prosthodontic and surgical considerations. St. Louis/Tokyo: Ishiyaku Euro America. Inc. Publishers. 1996.
- Lemon JC, Chambers MS, Wesley PJ, Martin JW. Technique for fabricating a mirror-image prosthetic ear. J Prosthet Dent 1996: 75: 292–293.

- K. Subburaj, C. Nair, S. Rajesh, S. M. Meshram, B. Ravi: Rapid development of auricular prosthesis using CAD and rapid prototyping technologies. Int. J. Oral Maxillofac. Surg. 2007; 36: 938–943.
- Mardini MA, Ercoli C, Graser GN. A technique to produce a mirror-image wax pattern of an ear using rapid prototyping technology. J Prosthet Dent 2005: 94: 195–198.
- 5. Freedman, David H. Layer By Layer. Technology Review. 2012; 115: 50-53.
- 6. Sun J, Zhang FQ. The application of rapid prototyping in prosthodontics. J Prosthodont 2012; 21: 641-644.
- 7. Torabi K, Farjood E, Hamedani S. Rapid prototyping technologies and their applications in prosthodontics, a review of literature. Journal of Dentistry. 2015;16(1):
- 8. Upcraft S, Fletcher R. The rapid prototyping technologies. Assembly Automation. 2003;23:318-30.
- 9. Shrestha B, Thaworanunta S. Orbital prosthesis fabrication: current challenges and future aspects. Open Access Surgery. 2016;9:21-8.

Source of Support: Nil; Conflict of Interest: None

Submitted: 09-12-2018; Accepted: 10-01-2019; Published: 27-01-2019