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CASE REPORT

The Use of CAD/CAM Trial Pattern for Facial Prosthesis Fabrication of a Maxillofacial Patient with Large Defect

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ABSTRACT

Treatment of maxillofacial patients needs a multidisciplinary approach of several expertise based on the complexity of the case. Prosthodontists often work together with e.g. ENT, oral or plastic surgeons to provide patient with better prosthesis and optimum treatment. **Case report:** A 55 years old male was referred to Dental Teaching Hospital of Universitas Indonesia for facial prosthesis fabrication. Patient had undergone squamous cell carcinoma ablation surgery that encompassed nose, cheek, sinuses, upper lip and most of the hard palate. Due to the extensive nature of the defect, Department of Prosthodontics collaborated with Department of Biomedical Engineering to employ 3D printing technique using general purpose machine for fabricating the trial pattern for the prosthesis, with attention given especially to margin areas and facial contours. This technique helps for prosthesis fabrication of this patient because manual wax carving is no longer necessary. Wax carving usually is a labor/skill intensive step and takes longer time. **Conclusion:** 3D printing of the trial pattern for the prosthesis help minimizes the labor/ skill intensive part of facial prosthesis fabrication.

Key words: 3D printing, maxillofacial prosthesis, multidiscipline, trial pattern

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INTRODUCTION

Facial defects can be caused by trauma, neoplasm treatment and congenital malformations.[1,2] The rehabilitation of those defects can be performed either by reconstructive surgery, prosthesis fabrication, or a combination of both. Type of rehabilitation depends on the patient's general health condition, the state of the tissue surrounding the defect and its vascularization, the visual observation of the defect state due to neoplasms, and the patient's ability to undergo or receive rehabilitation results.[1] Patients often prefer surgical reconstructions compared to prosthesis fabrication because they are permanent, but this will be difficult to do on large facial defects.[1] In certain circumstances, facial prosthesis will be better than reconstructions with surgery, for example in cases with high recurrence, patients undergoing radiation therapy, elderly patients that should undergo multiple reconstructive surgeries, and patients requiring a temporary prosthesis.[1]

Sometimes prosthesis fabrication is the only treatment option when patient's condition is not possible for surgical rehabilitation. There are some considerations that needs attention in prosthesis fabrication of large facial defects; such as properties of the materials available for facial restoration, the mobility of soft tissue around the defect, the difficulty of establishing retention and the ability of the patient to receive the prosthesis.[1] Retention of maxillofacial prosthesis can be adhesively- or implant retained.[1,3] Considerations to think about when choosing the retention method are the causes of the defect, the state of the tissue around the defect, and the cost.[1,4] In developed countries, clinicians used implant (92%) and magnetic retention in almost all cases of large facial defects whereas adhesively retained prosthesis are used as temporary prosthesis.[2] Fabrication of facial prosthesis for large defects takes time and good clinician's skill. Nowadays, technology can be used to help fabrication of facial prosthesis with large defects. Currently, the use of Computed Aided Design and Manufacturing (CAD/CAM) is increasing

in the field of health, especially maxillofacial.

The CAD/CAM technique is a three-dimensional object manufacturing technique with layering system using additive materials based on existing digital patterns which also known as rapid prototyping. This technique is widely used in the field of industry for the manufacture of aircraft and automotive spare parts. In the health field, it is used for the manufacture of surgical templates and educational aids and to manufacture stents for burn patients without pressuring the burn area. In addition, this technique is also used in the field of dentistry to make and shorten the manufacturing time of dental prosthesis; making custom made implants, templates for implant's placement, bone resection, bone transplantation; also as a tool for the treatment plan and fabrication of extra oral prosthesis.[5–8] There are several types of CAD / CAM techniques that can be used in dentistry such as stereolithography, fused deposition modeling, selective laser sintering, laminated object manucfacturing, multi-jet modeling inkjet technology, three dimensional printing (3D printing) and solid ground curing.[8] The deficiency of this technique are expensive cost, requires a specialized tool and need technician expertise.[8] Gamarra et al, used a camera phone and free software to convert two-dimensional photographs into three dimensions to obtain digital data in the fabricating of facial prosthesis,overcoming some of the deficiencies mentioned above.[9] Nevertheless, the CAD/CAM technique can provide a good compensation for the patient by simplifying fabrication using digital data from CT scan or MRI.

The use of CAD/CAM techniques in maxillofacial fields in developed countries has been rapidly evolving, including the manufacture of templates for reconstructive surgery, fabricating extra-oral prosthesis even in the trial pattern fabrication stage, making prosthesis' mold and extra-oral prosthesis itself.[5,6,8-12] In 2016, a preliminary research on the use of three-dimensional model applications in the case of maxillofacial reconstruction surgery was conducted in Indonesia.[13] The results of this study are similar to some reports that have been made in other countries that a three-dimensional model study can be used for the preparation of reconstructive surgery so that the surgical process lasts one to 1.5 times faster and the operating cost is cheaper compared with conventional one.[13] Trial patterns, prosthesis molds and the prosthesis fabrication can be done by using the same machine for three-dimensional models for maxillofacial reconstruction surgery. Trial patterns of large facial defect restorations is important because this stage influence the final outcome of the prosthesis to be made. Trial pattern in the maxillofacial cases aims to obtain a thin and adaptable margin, resemble the patient's skin texture so that the final prosthesis looks similar with the native tissue and cover the patient's defect. Unlike the use of CAD/CAM to make trial patterns, conventional fabrication requires good carving skills to obtain good prosthesis results. This article reports the use of CAD/CAM for the trial pattern fabrication for a large facial prosthesis.

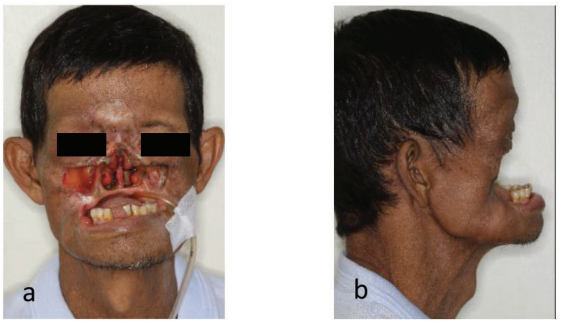

Figure 1. Extra oral photograph of the patient's defect (a) frontal side, (b) lateral side

CASE REPORT

A 55-year-old male patient was referred by the Department of Plastic Surgery Cipto Mangunkusumo General Hospital, Jakarta, Indonesia to Dental Teaching Hospital Universitas Indonesia, Jakarta, Indonesia to make facial prosthesis. The patient underwent tumor removal surgery in the nasal area about 11 years ago at the Depati Hamzah General Hospital in Bangka, Indonesia but there was recurrence two years later. In May 2015, the patient was referred to Cipto Mangunkusumo General Hospital, Jakarta, Indonesia and a month later surgery involving midfacial area was done (Figure 1). Based on the biopsy, the patient was diagnosed with infiltrative nodular cell type basal cell carcinoma.

Patient received 33 times radiotherapy treatment and five times chemotherapy. Then in August 2015, the patient returned to undergo a biopsy and the results showed basosquamous carcinoma histologic feature and some parts of the margins were not tumor-free. Because it was not possible to perform reconstructive surgery for this patient, the Department of Plastic Surgery Cipto Mangunkusumo General Hospital referred the patient to the Department of Prosthodontics Faculty of Dentistry Universitas Indonesia for facial prosthesis fabrication. Patient expected that after prosthesis is in place he could eat normally without using Naso Gastric Tube (NGT). After examination and discussion with the family of the patient, the patient agreed to make adhesively retained silicone facial prosthesis.

The initial stage after the patient approved the treatment plan was taking impression of patient's daughter face conventionally. The impression was poured in

Figure 2. The printing result of trial pattern (a) frontal side, (b) lateral side

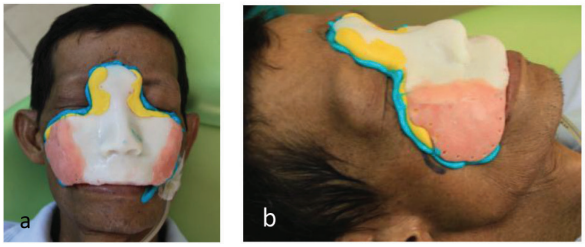

Figure 3. Margin adaptations after trial pattern modification (a) frontal side, (b) lateral side

dental stone type III and study model was scanned using 3D Scanner Ultra HD (Next Engine, USA), processed with CATIA software (Computer Aided Three-dimensional Interactive Application, Dassault Systémes, Villacoublay Cedex, France) to estimate the trial pattern margin manually. The data was stored in STL format. The predetermined data was then printed with Fused Deposition Modeling technique using U-Print Plus (Stratasys, USA).

The 3D model was printed in Acrylonitrile Butadiene Styrene (ABS) with an approximately 2 mm thickness (Figure 2). On the next visit, trial pattern try-in was performed and extension on the right and left side cheeks were required. A final wash impression on the margin with low viscosity polyvinyl siloxane material (Panasil, Kettenbach, Germany) was done (Figure 3).

The next step was making wax replica of the modified trial pattern. The wax pattern was checked on the patient for margin accuracy, shape and texture (Figure 4). After that, the facial prosthesis was made using pigmented silicone (Figure 5).

DISCUSSION

A good facial prosthesis rehabilitation should have a good shape, surface texture, color and transparency similar with the replaced soft tissue. Also, the margin of the prosthesis should blend with the surrounding tissues so the prosthesis are indistinguishable.[1] In the

Figure 4. Wax pattern try in (a) frontal view, (b) lateral view, (c) 12 o'clock view

Figure 5. Final prosthesis

rehabilitation of large facial defects, clinicians often have difficulty determining the shape and position of the prosthesis. When the treatment is done conventionally, carving the wax patterns of the prosthesis take long time especially for a non-experienced.[5] Based on this, clinicians may use CAD/CAM techniques for facial prosthesis fabrication.

The facial prosthesis fabrication for this patient is quite difficult due to the extensive defect and the unavailability of healthy tissue around the defects for retention of the prosthesis. Patient was hoping to eat normally, without using NGT. Based on anamnesis, clinical examination and medical history, it is known that the area around the defect was not tumor free so it is better to provide an adhesively retained prosthesis. Therefore, the patient is given information about the treatment plan along with the limitations of the prosthesis. The information is very important because patient's expectation of his prosthesis is quite high. Research on the quality of life of patients with cancer in the head and neck areas show high levels of emotional stress, physical limitations, facial or body shape changes and poor social relationships.[14] The quality of life of patients with extensive facial defects

is better when treated with implant supported prosthesis compared to adhesive facial prosthesis.[2,14] All that is expected from adhesively retained facial prosthesis was explained to the patient and his family.

One of the use of CAD/CAM techniques in facial prosthesis fabrication is the trial pattern fabrication. This method can shorten the processing time and patient visits. In the case of facial defect that is not affecting midfacial area, mirror image of patient's healthy side can be used to fill in the defect area.[7] As for cases with extensive facial defects and passes midfacial area, clinicians can use digital data which are stored in the database to find appropriate digital data that can fill the defect area.[7,10] Either way, margin and shape of the prosthesis which will be made for the patient is determined and printed using a CAD/CAM machine so that a trial pattern is obtained.

The CAD/CAM machines used in this case are general purpose machines. The scanner has dimensional accuracy options of ±0.005‟ and ±0.015‟. This scanner can save the scanning in STL format. The digital files are processed using CATIA software to form a prototype. This software can be used to create a mirror image of existing digital data but can not be used for superimposing digital data of the patients with the database. The resulting process of the software is printed using U-Print Plus. This printer can print with a thickness of 0.254 mm to 0.330 mm per layer, the thickness affect the texture of the trial pattern which need refining to resemble tissue texture. Printing is done using ABS materials. Plastic materials are widely used for the manufacture of mechanical parts and has an industrial grade. Therefore this material can be use as a trial pattern for facial prosthesis fabrication.

The use of CAD/CAM techniques in this case has several advantages such as clinicians have digital data that can be used repeatedly for the purpose of making a trial pattern or facial prosthesis. Trial pattern made with CAD/CAM technique can be adjusted for its thickness so that facial prosthesis can be made light while maintaining its shape. In addition, it creates shorter fabrication time, requiring less excellent clinical skills.[3,5]

The trial pattern in this case also has deficiency such as the margins of the trial pattern still need to be adjusted. This is because CATIA software can not be used for superimposing. Feng et al and Wu et al take the digital data of a patient defect using photographs or scans, next they superimpose the patient's data with data from the data bank.[5,10] By superimposing, the margin and shape of the prosthesis can be adjusted according to the area of the defect.[5,10] The printing result of current trial pattern has a texture that still needs to be modified in the wax pattern. This is influenced by the nozzle diameter of the printer used. Trial pattern made from ABS needs to be changed into wax pattern for easier improvement of texture and contour. Feng et al and Wu et al using Selective Laser Sintering technique using wax material so that trial pattern modification can be directly performed on the wax.[5,10]

CONCLUSION

Within limitations of the general purpose scanner, printer and software being used in fabricating facial prosthesis for this case, cooperation with the biomedical engineering in the use of CAD / CAM techniques to make trial pattern can reduce fabrication time by eliminating the need of labor/skill intensive part for extensive defects case.

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