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Place of 3D printing in facial epithesis☆

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ABSTRACT

Facial rehabilitation from facial epithets is part of the facial surgeon's therapeutic arsenal. The primary technique requires taking imprints on the patient, which has major drawbacks such as discomfort and difficulties for precisely recording anatomical surfaces. In this paper, we present a technical improvement in the design of facial epithesis, introducing application of a 3D printing technology. By exploiting digital data in DICOM format, it is possible to produce a digital copy of an epithesis. Based on this copy a model can be printed and then used to support the final prosthesis.

1. Introduction

If there is a failure of a surgical reconstruction or in first intention if there is a complex facial loss of substance, the facial rehabilitation by epithets remains a local technique available to facial surgeons.

The traditional method relies on taking an impression on the patient using alginate or silicone. From the silicone imprint, plaster casting and wax model is made, which is sculpted and retouched in order to obtain the most satisfactory suitable shape.

Then the wax model is placed into a mold for injection of silicone and from this time, we obtain the final epithesis [1].

In the field of maxillo-facial surgery, 3D printing has developed significantly over the last twenty years. It is now possible to make plates of osteosynthesis and cutting guides tailored.

Here, we present the place and the interest of 3D printing in the realization of facial epithesis.

2. Technical note

In the case of a facial defect with an indication of facial rehabilitation by epithesis, a joint prosthetist/surgical consultation is performed.

The analysis of the patient's photographs before the loss of substance is necessary in order to be able to discuss the objectives to be reached by the epithesis.

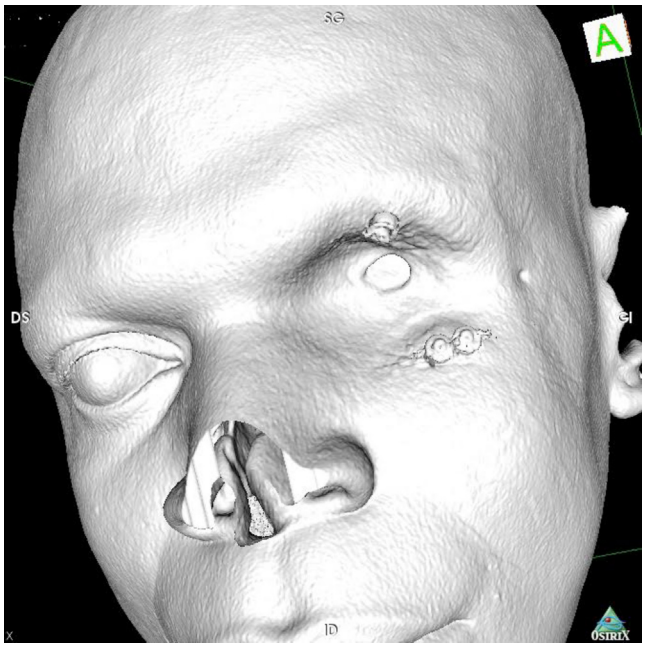

Fig. 1. Facial volume reconstruction by Osirix.

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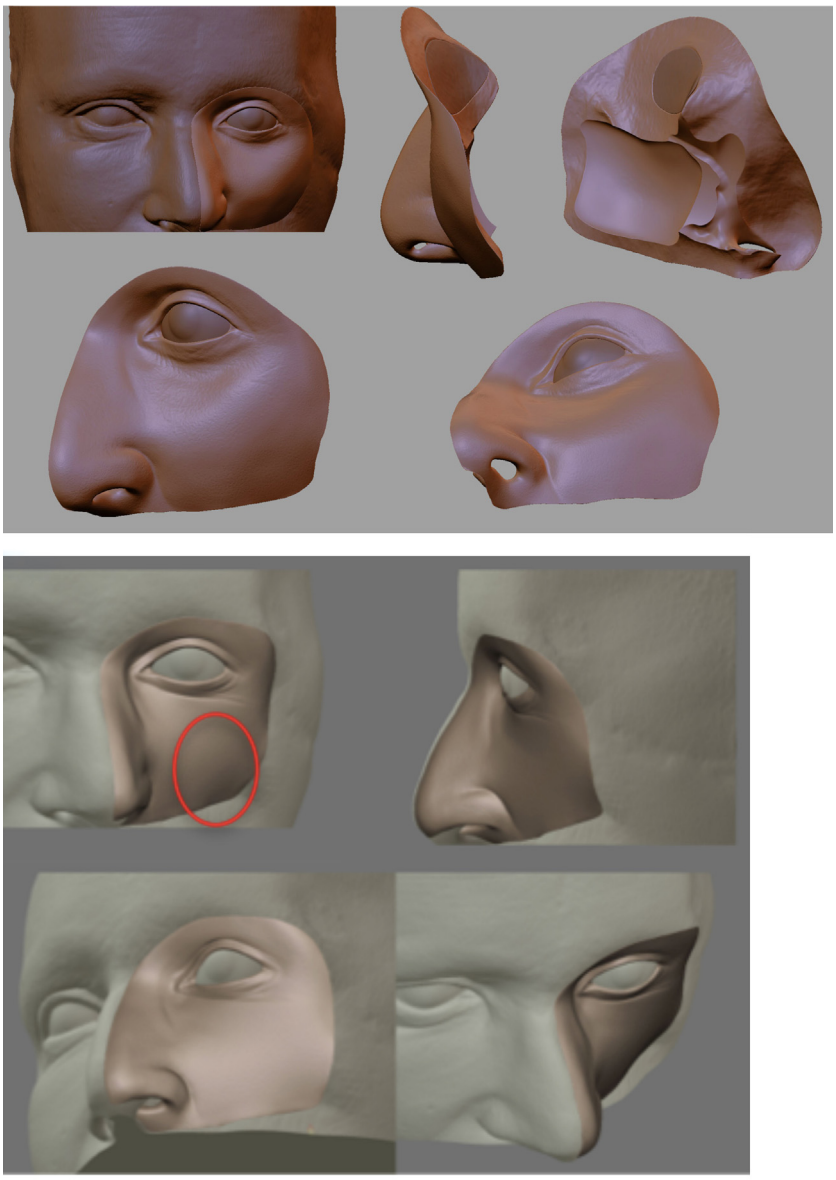


Figs. 2–3. Adaptation of the relief of the cheekbone desired by the patient (3D Coat–ZBrush).

In the event of facial rehabilitation by epithesis resulting from 3D printing, there is no need to take any footprint on the patient.

A craniofacial scanner without contrast agent is necessary (cutting thickness less than 1 mm) in order to be able to transmit the data in the DICOM format to the epithesist.

Using the Osirix software (version 5.8.5, Geneva, Switzerland) the CT data allows a 3D digital volume representation of the patient's face (Fig. 1).

The data are then extracted in "stl" format, filtered by the Meshlab software (ISTI – CNR, Italy), mesh cleaning: surface reconstruction and noise suppression.

The realization of a virtual epithesis is carried out using the 3D-Coat software (Pilgway®, Kiev, Ukraine) and ZBrush (Pixologic®, Los Angeles, USA) from the patient's photos and the joint consultation.

The result of this simulation is discussed between the patient and the surgeon. Adjusments are realized if they can benefit to the final project (Figs. 2–3).

Once the quality of the digital simulation is satisfactory, the data are transmitted for printing. In order for a test to be carried out on the patient, the impression is a resin model that is duplicated in a pulp color wax. Also, adjustments can be made, if necessary (Figs. 4).

Once the final model has been validated, any changes are carried over to the virtual simulation for backing up the data.

The final model in wax is put into a mold for injection of silicone, which has been previously tinted, with the same color than the patient's skin (using natural pigments). Then, the epithesis is put in place fixed by skin adhesives or implants.

3. Discussion

There are several advantages using 3D printing for the realization of facial epithesis. First of all, the production of a digital model without the need for a physical impression eliminates a complicated clinical time, with risk of leakage of the impression product in the natural cavities and poor tolerance by the patient. Furthermore, these impression products (alginate or silicone) cause a ptosis of the tissues during their application, which results in a modification of the configuration of the recipient site [2–5]. The use of digital simulation eliminates bias associated

Fig. 4. Resin ear flap and duplicate color wax skin for patient testing.

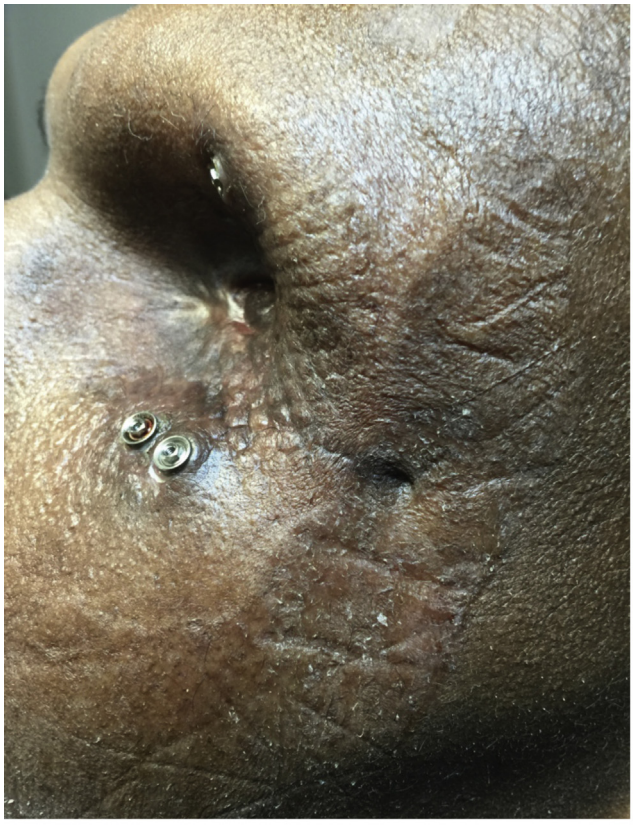
with the mass of products used for fingerprinting. In addition, since silicone prostheses have a limited lifetime, another advantage of using CAD/CAM (Computer-Aided Design and Manufacturing) is related to computer backups. The epithesist equipped with this technology can achieve and duplicate limitless new prosthesis identical, with a significant time saving for everyone because all previous steps are not necessary.

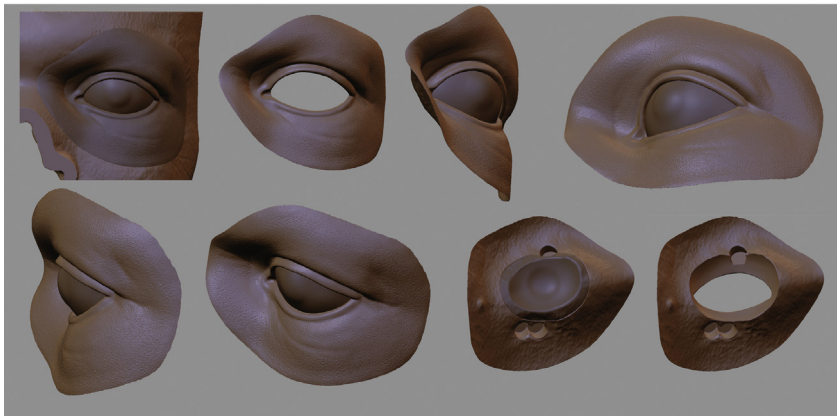
The epithesis from 3D printing are made thanks to the use of the computer techniques called "mirroring" allowing an identical result to the opposite side for the loss of lateralized substance.

And in all cases, these epithesis are associated with an intrados adjusted precisely to the recipient site.

The digital simulations can take into account the extraoral implants [6,7] intended to support the epithesis (Figs. 5–6).

An additional benefit of using 3D printing in the realization of facial epithesis [8] is the ability to work remotely. Indeed, the patient only has to meet the surgeon and the epithesist once, to discuss the modalities of rehabilitation. The rest of the work can be





Figs. 5–6. Periorbital extraoral implants and customized epithesis numerical simulation.

done without the need for the patient to be present, until the test phase of the wax model.

In conclusion, the use of digital simulation related to 3D printing allows the obtaining of more accurate facial epithesis and less morbid realization for the patient.

Computer backups prevent the degradation of the imprint (renewed every two years). Therefore, this technology has become the new gold standard for craniofacial rehabilitation by epithesis.

Disclosure of interest

The authors declare that they have no competing interest.

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