Contours Identification in Modelling Facial Silicone Epistasis

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To achieve a modeling of the epithesis as close as possible to the lost organ, information on its size and shape can be registered by using computed tomography and 3D reconstruction. This paper aims to investigate to what extent the recording geometry of facial regions using computed tomography and identify on the sections of computed tomography the contour of the region to be reconstructed for virtual modeling of future silicone epithelium can be achieved. The results were obtained by applying the algorithm described in C + + program and contour detection in computed tomography images recorded preoperatively in patients who were to receive resection surgery of a facial region followed by reconstruction of the defect by facial epithesis.

Keywords: acrilic resins, contour detection

Resection of various facial anatomical formations due to the presence of a malignant tumor leads to the alteration of various functions but especially the esthetic function. Resection surgery of the various regions of the face requires the reconstruction of such facial region during the second stage, to restore lost esthetic function [1]. Depending on the etiology of loss of substance, epithesis are indicated in: malignant tumors requiring very large excision surgery with facial mutilations (malignant neoplasms, skin, bone, intracavitary tumors); osteoradionecrosis, secondary to a pre- or postoperative radiant treatment; burns, as a question of skin fragility and keloid scars; and in traumas with extensive loss of substance at the level of soft tissues and bone [2]. Due to their special properties, rubbers and silicone oils found application in surgery and other areas of medicine [7-9]. Decisive for their use are in part their thermostability that allows sterilization at high temperatures and, in part, their gliding and rejection ability as well as their surface activity (anti-foaming).

In all cases, however, the physiological indifference of the silicone-methyls, which is added to the silicone rubber and lack of plasticizer additives in the respective vulcanisations, gave the primary impetus to use these products.

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This paper aims to investigate to what extent the following can be achieved:

- recording geometry of facial regions using computed tomography
- identify on the sections of computed tomography the contour of the region to be reconstructed for virtual modeling of future silicone epithelium.

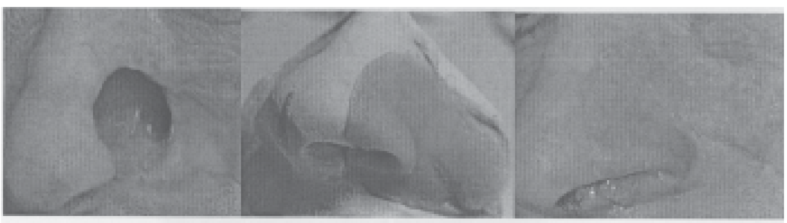

Fig 1. Steps to achieve a nasal wing epistasis

Experimental part

The main steps in making silicone epithesis are: patient examination and treatment plan development, imprinting the prosthetic field, casting the working model, achieving the wax layout of epithesis, layout trial in in practice, preparing silicone color, packing the layout and carrying out the stencil/pattern, tamping the silicone in the printer, cooking, unpacking and finishing denture and adaptation of the epithesis to the patient (fig 1).

We can intervene in the stage of preparing the layout by preoperative registration of the geometry of the region to be resected and transferring the data through 3D printing in order to make the model. Registration of the spatial geometry is done according to two-dimensional computed tomography sections. The first step in image processing of tomography is to identify the contours of the various components that make up the image.

A contour detection method is to calculate the grayscale gradient of the image section at each point [3, 6]

$$\vec{G} = \left(G_{x,}G_{y}\right) \qquad G_x = \frac{\partial I_r(x,y)}{\partial x} \qquad G_y = \frac{\partial I_r(x,y)}{\partial y} \tag{1}$$

Contour direction can be determined considering that the gradient is perpendicular to the contour at each point. Different contour points will be determined by comparing the gradient with a chosen value.

The digital image is composed of points with different gray values g (i, j) located at unitary distances. These correspond to different brightness In(x, y). It can be written as following:

$$\left|\vec{G}\right| = \sqrt{[g(i,j)-g(i+1,j)]^2 + [g(i,j)-g(i,j+1)]^2} \tag{2}$$

or:

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$$\left|\vec{G}\right| = \left|g(i,j) - g(i+1,j)\right| + \left|g(i,j) - g(i,j+1)\right| \quad (3)$$

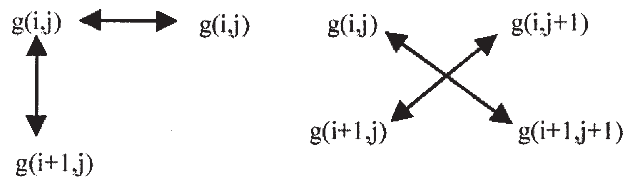

Fig 2. Quick method for calculating the gradient

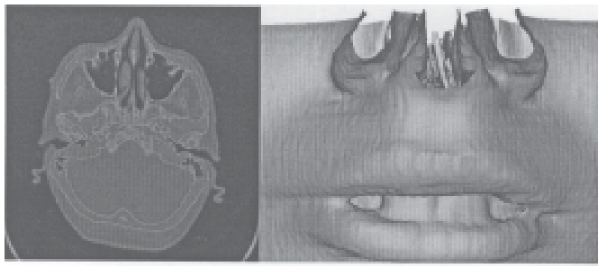

Fig 3 a. Identification of the bone contour on computed tomography section, b. Outer surface of a 3D reconstruction based on CT sections

Roberts approximation that uses cross differences (fig 2) improves contour detection in situations where the gradient varies very little [4]. It can be written:

$$\left|\vec{G}\right| = \left|g(i,j) - g(i+1,j+1)\right| + \left|g(i+1,j) - g(i,j+1)\right| \quad (4)$$

By comparing |G|with a threshold value T we can obtain: $\left|\vec{G}\right| \geq T$, situation where the point is on the contour, or $\left|\vec{G}\right| < T$, situation where the specific point is not included in the contour[3].

Results and discussions

The results were obtained by applying the algorithm described in C + + program and contour detection in computed tomography images recorded preoperative in patients who were to receive resection surgery of a facial region followed by reconstruction of the defect by facial epithesis. By 3D integration of contours we were able to achieve 3D model of the region and therefore the virtual model of epithesis (fig 3).

The 3D surface of the model represents the union of all contours determined from the section images. Therefore, the determination of individual contour for each section depends not only on precise determination, but also on the possibility of achieving spatial continuity of several contours. A very useful tool for spatial linking of contours is Hough transformation [5].

Conclusions

This paper presents the contour shaping of the various elements of an image based on the transformation principles envisaged by Hough. The algorithm shows the possibility to improve silicone epithesis modeling skills based on the three-dimensional model of facial extremity registered with CT. The advantages obtained in this case are: relatively low volume of calculation, obtaining the contour direction when taking into account formula signs and relative independence of the threshold in relation to the type of image.

Silicones can be used successfully in epithesis of patients with large defects resulting from resection surgery of various facial tumors. In the modeling of silicone epithesis the tridimensional digital methods play an important role because of the opportunities they offer in copying original facial geometry of the patient.

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