Development of a Stereophotogrammetry Technique to Assess Facial Change Following Surgery for Head and Neck Cancer

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A stereophotogrammetry technique is described that can be used to map the face following surgery for head and neck cancer. It enables the effects of obturators on facial form to be assessed and may have a wide variety of applications. *Int J Prosthodont 2011;24:342–344.*

Head and neck cancer can be a very distressing disease with significant associated mortality.[1] Patients who undergo treatment to remove the diseased tissues can incur major limitations in oral function. This would include difficulties in chewing, swallowing, and speech. Removal of tissues and the supporting bony structures from within the mouth (eg, a hemimaxillectomy in which a significant portion of the maxilla is removed) may result in changes to facial form, which will affect the patient's self-confidence and the way they interact with other people. Such patients are commonly rehabilitated by means of an obturator (a removable prosthetic appliance that replaces the teeth and missing tissues).

Although, subjectively, it is thought that obturators do contribute to an improved facial appearance following surgery, these effects have been difficult to measure. Stereophotogrammetry is an imaging technique used to capture objects three-dimensionally. The purposes of this study were to determine if a stereophotogrammetry technique could be used to capture facial form following surgery for head and neck cancer and to determine if there was a potential to measure the effects of obturators on facial form.

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Materials and Methods

A stereophotogrammetry three-dimensional (3D) image capture and analysis system (Dimensional Imaging) was used to map the face. Mapping involved recording a photograph of the facial tissues through the use of four linked cameras (Figs 1a and 1b) to capture simultaneous photographs of the patient (Fig 2). This enabled 3D surface images to be produced.

The resulting images could be displayed in many different ways. The dimensional imaging software program allowed a 3D image to be assembled from the data recorded by the individual cameras. This image was converted into a stereolithographic format, which stored the 3D information.

A specific software program (Cloud, Robins3d) was developed to measure the differences between overlaying stereolithographic images by registering areas of the facial tissues that were stable. This allowed the effects of an obturator on facial form to be studied.[2,3]

Results

The technique was first explored in a patient with normal dentofacial form, where it was found that the system of recording and overlaying images was accurate to a resolution of approximately 0.5 mm (the image capture system has an error value of < 0.2 mm).

The effect of an obturator on restoring facial form was then studied in a 74-year-old woman with a maxillary defect on the right side as a result of the surgical removal of a giant cell tumor. She was partially dentate in both the maxilla and mandible. The overlaid images of the patient with and without the obturator (Fig 3) showed clear changes in facial form, which were displayed as difference values (Fig 4). In some areas, these differences were up to 10 mm. The net volume difference of the facial form, with and without the obturator, was calculated to be 3,498 mm^3.

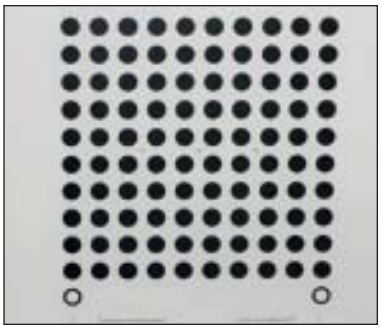

Fig 1a *(left)* The stereophotogrammetry equipment (the patient sits in front of the blue background).

Fig 1b *(right)* The distances between the four linked cameras are calibrated using a grid prior to placing the patient in front of the blue screen.

Fig 2 Four individual images were captured by the linked digital cameras.

Discussion

This preliminary study showed that the development of a stereophotogrammetry technique had significant potential to assess changes of facial form during the rehabilitation of patients who have been treated for head and neck cancer.

For this patient, it was apparent that the obturator had a significant effect on the restoration of facial form by giving substantial support to the facial tissues in the anterior region of the maxilla. Although it may be possible to see an effect on facial form by looking at an individual, the technique can be used to quantify and display volume differences for patients who have been rehabilitated with obturators. Furthermore, given that the resection of such lesions may have significant effects on quality of life,[3] there would be scope for assessing the impact of facial change on this. The technique is also likely to have a wide variety of applications in the measurement of changes in relation to growth as well as congenital[4,5] and acquired deformity of the tissues of the head and neck. This requires further study.

Fig 3 Alignment of the superimposed images of a patient who had a maxillary resection on the right side. Frontal image of the patient **(a)** without and **(b)** with the obturator in place. **(c)** One of the pair of stereolithographic images that, after alignment, could be used to determine volume changes in the tissues. The shaded area *(orange)* over the face represents the site of the resection. The eyes and hair have also been shaded because these are not used in the surface registration process since they are not stable areas.

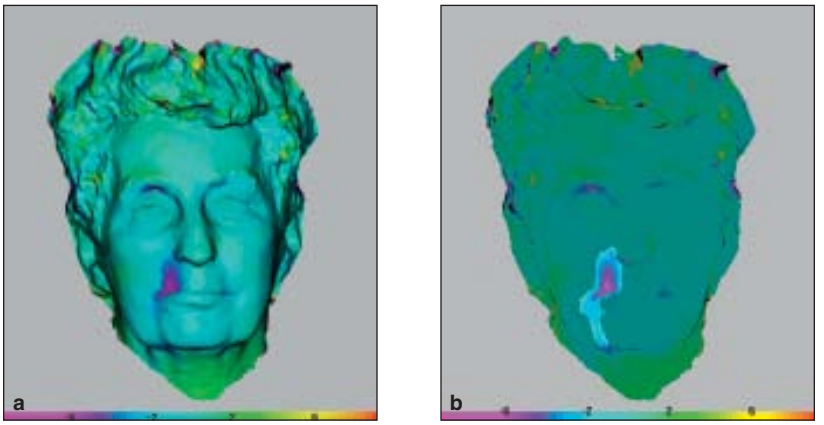

Fig 4 Calculation of the volume difference between superimposed images of the patient. **(a)** Superimposition of the stereolithographic images derived from the facial images shown in Figs 3a and 3b with difference values displayed in a color-coded format. The purple area shows clearly how the obturator contributes to the rehabilitation of facial form. **(b)** The painted area used to calculate the difference in volume.

Conclusion

In patients who have been treated for head and neck cancer, stereophotogrammetry can be used to capture and measure the restoration of facial form by an obturator. It is likely that the technique can also be used to assess the effects of surgery in this group of patients. This requires further study.

References

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