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Three-dimensional visualization of the human face using DICOM data and its application to facial contouring surgery using free anterolateral thigh flap transfer

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KEYWORDS
Facial contouring surgery;
Free flap;
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Summary One of the main challenges faced by surgeons performing reconstructive surgery in cases of facial asymmetry due to hemifacial atrophy or tumor surgery is the restoration of the natural contour of the face. Soft-tissue augmentation using free-flap transfer is one of the most commonly used methods for facial reconstruction. The most important part of a successful reconstruction is the preoperative assessment of the volume, position, and shape of the flap to be transplanted.

This study focuses on three cases of facial deformity due to hemifacial progressive atrophy or tumor excision. For the preoperative assessment, digital imaging and communications in medicine (DICOM) data obtained from computed tomography was used and applied to a three-dimensional (3D) picture software program (ZedView, LEXI, Tokyo, Japan). Using computer simulation, a mirror image of the unaffected side of the face was applied to the affected side, and 3D visualization was performed. Using this procedure, a postoperative image of the face and precise shape, position, and amount of the flap that was going to be transferred was simulated preoperatively.

In all cases, the postoperative shape of the face was acceptable, and a natural shape of the face could be obtained. Preoperative 3D visualization using computer simulation was helpful for estimating the reconstructive procedure and postoperative shape of the face. Using free-flap transfer, this procedure facilitates the natural shape after reconstruction of the face in facial contouring surgery.

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Introduction

One of the most difficult challenges faced by surgeons performing reconstructive surgery is the reconstruction of facial asymmetry due to congenital anomaly, progressive hemifacial atrophy, injury, or tumor excision. The reconstructive procedure depends on the cause of the deformities. Osteotomy and osteodestruction of the facial bone, bone graft, soft-tissue augmentation or both are commonly chosen for reconstruction of the facial deformities.[1–9] It is ideal to perform all the procedures described earlier to complete symmetrical reconstruction. However, this is not always possible. When the patient's general condition is not good or when functional reconstruction, including occlusion adjustment, is not necessary, then only the soft-tissue augmentation procedure is chosen.[6] In such cases, the aim of reconstruction is not to achieve complete symmetry but to give a "natural appearance." In order to do so, the preoperative assessment of the position, size, and shape of the tissue that is going to be transferred is important.

This study focuses on three cases of facial deformity due to hemifacial progressive atrophy and tumor excision. Patients underwent preoperative simulation using digital imaging and communications in medicine (DICOM) data obtained from computed tomography, and the results were used for the planning of facial contouring surgery with free-flap transfer.

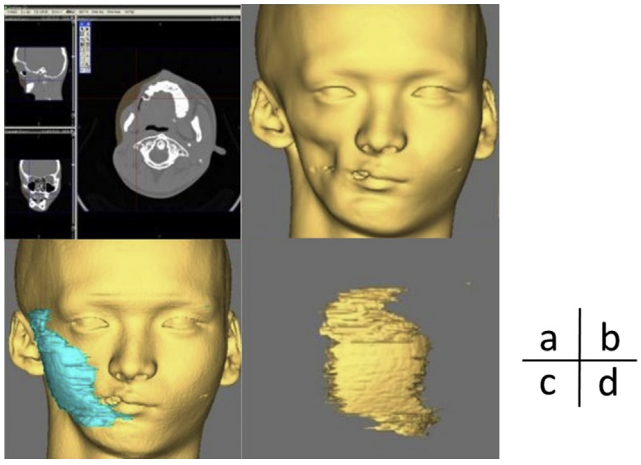

Figure 1 a) The DICOM data of case 1. The DICOM data were applied to the 3D picture software program (ZedView, LEXI, Tokyo, Japan). b) Using the 3D picture software program, a 3D model of the patient's face was made. c) A mirror image was generated and the unaffected side was applied to the affected side and 3D visualization was performed. If the appearance of the simulated face was not natural, then the shape of the face was adjusted using a drawing tool or eraser tool. d) The precise amount, shape, and position of the flap that was going to be transferred were assessed using the 3D picture software program.

Methods

Preoperative computer simulation

Preoperative enhanced computed tomography was performed before the free-flap transfer. The aims of this study were twofold: (1) to assess the recipient vessel for free-flap transfer and (2) to perform preoperative 3D simulation surgery using this DICOM data. The DICOM data were applied to 3D picture software program (ZedView, LEXI, Tokyo, Japan) (Figure 1a). Using this software, a 3D model of the patient's face (Figure 1b) with a subsequent mirror image was created. The unaffected side was applied to the affected side, and 3D visualization was performed (Figure 1c). If the appearance of the simulated face was not natural, then the shape of the face was adjusted using a drawing or eraser tool. Using this procedure, the precise amount, shape, and position of the flap that was going to be transferred were assessed preoperatively (Figure 1d).

Operative procedure

The flap design was determined in accordance with the preoperative computer 3D simulation. In all cases, a free anterolateral thigh flap was used for facial contouring surgery. The shape and thickness of the flap were adjusted during the operation (Figure 2b). A subcutaneous pocket was created at the recipient site according to the preoperative computer simulation. Then, the flap was de-epithelialized and transferred to the subcutaneous pocket (Figure 2c).

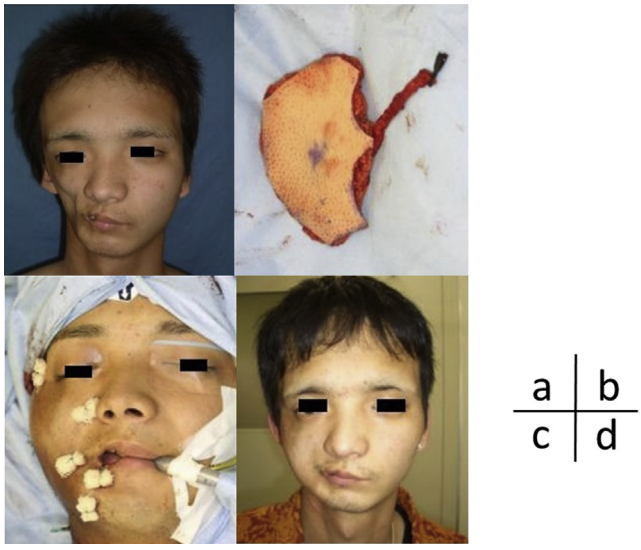

Figure 2 Case 1 a) A 20-year-old male presented to our clinic with progressive hemifacial atrophy on the right side of his face. b) According to the computer simulation, the flap was elevated and a flap transfer was performed. The size of the flap was 7 × 14 × 2.5 cm c) The de-epithelialized anterolateral thigh flap was introduced into the subcutaneous pocket. d) Two years after the operation, a natural facial appearance was obtained, and the patient was satisfied with the result.