Mandibular Reconstruction Assisted by Preoperative Simulation and Accurate Transferring Templates: Preliminary Report of Clinical Application

Guang-sen Zheng, DDS, PhD, * *Yu-xiong Su, DDS, PhD,*† *Gui-qing Liao, MD, DDS, PhD,*‡ *Hai-chao Liu, DDS,*§ *Si-en Zhang, DDS,*‖ *and Li-zhong Liang, DDS*¶

Purpose: This study investigated the application of a computer-aided design and manufacturing technique of defining tumor resection, fibula cutting, and positioning by surgical templates in mandibular reconstructive surgery.

Materials and Methods: Four patients who required mandibulectomy and simultaneous reconstruction were enrolled in this study. Preoperative surgical simulation was performed. The surgical templates that defined tumor resection, fibula cutting, and positioning were designed and fabricated.

Results: The surgeries were performed to the preoperative plan. All flaps survived. Superimposition of the postoperative image and the preoperative plan showed a satisfactory surgical accuracy.

Conclusions: This method of defining tumor resection, fibula cutting, and positioning by surgical templates was accurate enough for mandibular reconstructive surgery.

J Oral Maxillofac Surg 71:1613-1618, 2013

Segmental mandibular defects caused by tumor, trauma, or infection severely impair facial esthetics and mastication, respiration, phonation, and deglutition. Reconstructive surgery is necessary to improve quality of life in these patients. However, the unique configuration of the mandible complicates reconstructive surgery. The increasing application of computer-aided design and manufacturing techniques have simplified this challenging procedure. Initially, the prefabrication of mandibular stereo models by the rapid prototyping technique allowed surgeons to accommodate the reconstruction plate preoperatively to rebuild a patient's original facial contour.[1,2] Then, preoperative surgical simulation made mandibular reconstructive surgery more predictable.[3,4] Recently, surgeons and engineers have focused on how to implement the surgery accurately to the preoperative simulation.[5,6]

The authors developed a method for accurately transferring the preoperative simulation to the actual surgery using resection, fibula cutting, and positioning templates.[7] An accuracy study of cadaveric surgery proved that bone segments of the grafts and mandibular remnants could be positioned accurately according to the preoperative simulation with the assistance of templates. The present study investigated the clinical application of this method for guiding mandibular reconstructive surgery.

Materials and Methods

PATIENTS

Four patients who required mandibulectomy and simultaneous reconstruction were enrolled in the study. The study was approved by the ethics

Received from the Department of Oral and Maxillofacial Surgery, Guanghua School of Stomatology, Sun Yat-sen University, Guangzhou, China.

*Lecturer.

†Associated Professor.

‡Professor.

§Lecturer.

‖Resident.

¶Resident.

Address correspondence and reprint requests to Dr Liao: Department of Oral and Maxillofacial Surgery, Guanghua School of Stomatology, Sun Yat-sen University, Guangzhou, China 510055; e-mail: drliaoguiqing@hotmail.com

0278-2391/13/00212-7$36.00/0

http://dx.doi.org/10.1016/j.joms.2013.02.018

Table 1. PATIENT DEMOGRAPHIC DATA

Case	Age (yr)	Gender	Diagnosis	Site	Fibula Patterns	Fixation
1	32	male	ameloblastoma	left body and ramus	4 segments, double barreled	reconstruction plate
2	34	male	chondrosarcoma	bilateral body	6 segments, double barreled	reconstruction plate
3	42	male	osteoradionecrosis	right body and ramus	2 segments, single barreled	reconstruction plate
4	56	male	gingival carcinoma	left body	2 segments, single barreled	miniplate

Zheng et al. Virtual Planning of Mandibular Reconstruction. J Oral Maxillofac Surg 2013.

committee of Guanghua School of Stomatology, Sun Yat-sen University (Guangzhou, China).

Helical computed tomography of each patient was performed with a slice thickness of 0.5 mm (Aquilion 64-Slice Computed Tomographic Scanner, Toshiba, Tokyo, Japan). Data were imported into Mimics 10.01 (Materialise, Leuven, Belgium) and converted into virtual 3-dimensional maxillas, mandibles, and fibulas.

SURGICAL TEMPLATE DESIGN AND FABRICATION

The design and fabrication of the surgical templates were identical to the authors' previous study.[7]

Mandibular Resection Template Design

According to the characteristic of the lesion, mandibulectomy was simulated by locating the cutting planes on the mandible. After the lesion was resected, mandibular remnants were left. Anchor pin guides were placed on the mandibular remnants. The mandibular resection template was designed according to the mandibular contour, cutting planes, and anchor pin guides.

Positioning Template Design

The fibula was cut into rough segments, placed in the mandibular defect, and trimmed by cutting planes at bone union sites to form 1-mm gaps. Anchor pin guides, originally on the mandibular remnants and then on the fibular segments, were placed. The positioning template was designed according to the contour of the new mandible and anchor pin guides.

Fibula Cutting Template Design

The precisely trimmed fibular segments on the new mandible and the corresponding anchor pin guides were returned to the original positions on the fibula. The fibula cutting template was designed according to the fibula contour, cutting planes, and anchor pin guides.

SURGERY

Surgery was carried out using a 2-team approach. First, after the templates were placed and locked temporally on the mandibles and fibulas, the cutting of bone was performed by leaning the sagittal saw against the cutting guides. Second, the fibular segments and mandibular remnants were unlocked, switched to the positioning templates, and locked temporally with screws. Third, the fibular segments and mandibular remnants were fixed with titanium plates.

Results

PATIENT INFORMATION

The demographic data and clinical characteristics of the patients are listed in Table 1. Four male patients (age range, 32 to 56 yr; mean, 41 yr) were enrolled in this study. One patient had ameloblastoma of the mandible, 1 had chondrosarcoma, 1 had osteoradionecrosis of the mandible, and 1 had lower gingival carcinoma.

FIGURE 1. A mass is visible on the buccal side of the lower left gingiva.

Zheng et al. Virtual Planning of Mandibular Reconstruction. J Oral Maxillofac Surg 2013.