JAPANESE DERMATOLOGICAL ASSOCIATION
THE JOURNAL OF DERMATOLOGY

Three-dimensional modeling and printing facilitate preoperative simulation and planning in skin surgery

Journal:	*The Journal of Dermatology*
Manuscript ID	JDE-2016-0237.R2
Wiley - Manuscript type:	Letter to the Editor
Date Submitted by the Author:	n/a

Complete List of Authors:	Yokota, Kenji; Nagoya University Graduate School of Medicine, Department of Dermatology Matsumoto, Takaaki; Nagoya University Graduate School of Medicine, Dermatology Murakami, Yoshie; Nagoya University Graduate School of Medicine, Department of Dermatology Ando, Kaori; Nagoya University Graduate School of Medicine, Department of Dermatology Akiyama, Masashi; Nagoya University Graduate School of Medicine, Department of Dermatology

Keywords:	3D, 3D printer, three-dimensional model,, 3-dimensional print, simulation

Abstract:	Recently, three-dimensional (3D) modeling and printing technology using 3D imaging software and 3D printers has been used in preoperative simulation and planning for various surgical operations at various body sites. However, 3D modeling and printing have rarely been reported in the field of skin surgery. We report here two cases of malignant skin tumors—a malignant melanoma of the face, and dermatofibrosarcoma protuberans on the thigh—to which we successfully applied 3D modeling and printing technology for preoperative surgical simulation and planning. The present cases suggest that 3D modeling and printing may facilitate the simulation and planning of operation methods and contribute to successful operations in dermatology.

Journal of Dermatology

Manuscript ID JDE-2016-0237 Second Revised Version

Letter to the Editor
Case Letter

Three-dimensional modeling and printing facilitate preoperative simulation and planning in skin surgery

Kenji YOKOTA, Takaaki MATSUMOTO, Yoshie MURAKAMI, Kaori ANDO, Masashi AKIYAMA

Department of Dermatology, Nagoya University Graduate School of Medicine, Nagoya, Japan

Word count: 496 words in the main text, 1 figure, 0 tables, 5 references
Key words: 3D, 3D printer, three-dimensional model, 3-dimensional print, simulation
Funding sources: None
Conflicts of interest and financial disclosures: None to declare
Acknowledgements: None

Correspondence:
Prof. Masashi Akiyama
Department of Dermatology
Nagoya University Graduate School of Medicine
65 Tsurumai-Cho, Showa-ku, Nagoya, Aichi 466-8560, Japan
Tel: +81-52-741-2314 Fax: +81-52-744-2718
E-mail: makiyama@med.nagoya-u.ac.jp

Recently, three-dimensional (3D) modeling and printing technology has been used in preoperative simulation and planning for various surgical operations at various body sites.[1,2] However, 3D modeling and printing have rarely been reported in the field of skin surgery. We report here two cases of malignant skin tumors to which we successfully applied 3D modeling and printing technology for preoperative surgical simulation and planning.

Case 1: A 77-year-old woman had a recurrent lesion of malignant melanoma (MM) on the right cheek (Fig. 1a). One year after the total resection of the primary tumor, a MM recurred locally at the primary site as a subcutaneous nodule 3cm in diameter. Contrast CT images showed that the tumor had infiltrated into the jaw bone (Fig. 1b).

Preoperative surgical simulation was performed as follows. The equipment used was the Zed View® 3D preoperative imaging software (LEXI Co., Ltd., Japan), the Geomagic Freeform® touch-sensitive digital modeling system (SYSTEMCREATE Co., Ltd., Japan) and the ProJet 660Pro® 3D printer (Emco, UK). From 1mm-thick slices of contrast CT images, a 3D model of the tumor and the surrounding bones, skin and blood vessels was created (Fig. 1c)[3], and we printed a 3D model for further planning of the operation (Fig. 1d).[4,5] We performed preoperative simulation of cutting 1cm around the lesion, including a portion of the maxilla and nasal septum, by the touch-screen interface digital modeling system (Fig. 1e). In addition, we utilized the printed 3D model in explaining the operation plan to the attending surgeons and to the patient. The actual surgery was successfully performed as planned (Fig. 1f).

Case 2: A 68-year-old man had a nodular lesion of dermatofibrosarcoma protuberans (DFSP) on the left thigh (Fig. 1g). He had a red nodule of 3 × 2 cm in size from the left thigh to the groin. The tumor had expanded close to the great saphenous vein (Fig. 1h).

Using methods similar to those for Case 1, preoperative surgical simulation was performed. From thin slices of contrast CT images, both a virtual 3D model and a printed 3D model of the tumor, the femoral artery and vein, and the great saphenous vein were created (Fig. 1i, j). Using these 3D models, we performed preoperative simulation of an operation to resect 2cm around the lesion,

including the great saphenous vein (Fig. 1k). The printed 3D model was used for explaining the operation procedures to the medical staff and to the patient. The actual surgery was conducted successfully as simulated and planned (Fig. 1l).

The preoperative simulation with 3D reconstruction and modeling was useful in confirming surgical procedures in skin surgery.

In Case 1, we skin surgeons performed the total resection and reconstruction operation in cooperation with head and neck surgeons and plastic surgeons. We consider that, in such a collaborative operation with surgeons of different specialties, 3D modeling and printing are extremely powerful tools to facilitate preoperative simulation/planning of operation methods and procedures, and for the attending surgeons to share detailed information on operation plans.

References

1. Gateno J1, Xia JJ, Teichgraeber JF, *et al.* Clinical feasibility of computer-aided surgical simulation (CASS) in the treatment of complex cranio-maxillofacial deformities. *J Oral Maxillofac Surg* 2007; **65**: 728-734.

2. Dziegielewski PT, Zhu J, King B, *et al.* Three-dimensional biomodeling in complex mandibular reconstruction and surgical simulation: prospective trial. *J Otolaryngol Head Neck Surg* 2011; **40** (Suppl 1): S70-81.

3. Mazza E, Barbarino GG. 3D mechanical modeling of facial soft tissue for surgery simulation. *Facial Plast Surg Clin North Am* 2011; **19**: 623-637.

4. Cheung CL, Looi T, Lendvay TS, Drake JM, Farhat WA. Use of 3-dimensional printing technology and silicone modeling in surgical simulation: development and face validation in pediatric laparoscopic pyeloplasty. *J Surg Educ* 2014; **71**: 762-767.

5. Kurenov SN, Ionita C, Sammons D, Demmy TL. Three-dimensional printing to facilitate anatomic study, device development, simulation, and planning in thoracic surgery. *J Thorac Cardiovasc Surg* 2015; **149**: 973-979.

Figure legends

Figure 1 Clinical features, 3D models and surgical simulation/planning in Cases 1 and 2.
(a) The recurrent lesion of malignant melanoma on the right cheek. (b) Contrast CT images show infiltration of the tumor into the jaw bone. (c) 3D preoperative modeling of the tumor (the yellow mass) and the surrounding bones, skin and blood vessels (arteries in red; veins in blue). (d) The 3D model made by the 3D printer for further planning of the operation. The tumor mass is marked with a yellow circle. (e) We performed preoperative simulation of cutting 1cm around the lesion, including parts of the maxilla and the nasal septum, by the touch-screen interface digital modeling system. The area to be resected is marked with a dotted line circle. (f) In actual surgery, the tumor was resected successfully as planned (dotted-line circle).
(g) The nodular lesion of DFSP from the left thigh to the groin. (h) MRI images reveal that the tumor is close to the great saphenous vein. (i, j) From thin slices of contrast CT images of the patient's lesion, both a virtual 3D model (i) and a printed 3D model (j) of the tumor, the femoral artery and vein, and the great saphenous vein are created. (k) Using the 3D model, we performed preoperative simulation of an operation to resect 2cm around the lesion, including the great saphenous vein (dotted-line circle). (l) The actual surgery was conducted successfully as simulated and planned. The resected area is marked with a dotted-line circle.

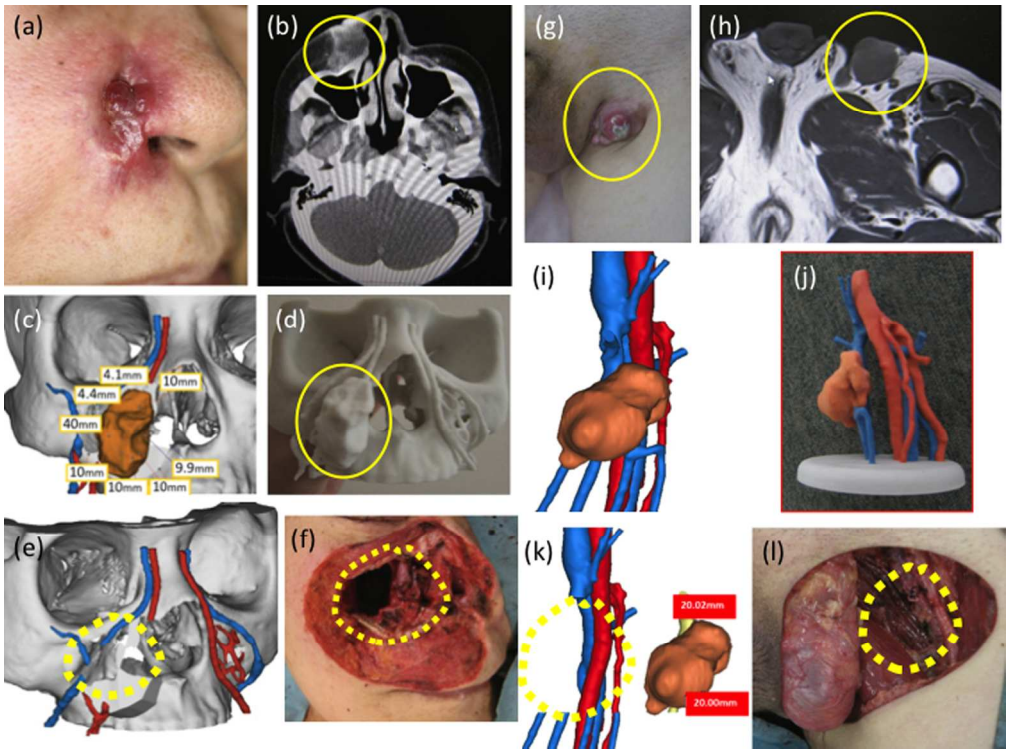

Figure 1 Clinical features, 3D models and surgical simulation/planning in Cases 1 and 2.
(a) The recurrent lesion of malignant melanoma on the right cheek. (b) Contrast CT images show infiltration of the tumor into the jaw bone. (c) 3D preoperative modeling of the tumor (the yellow mass) and the surrounding bones, skin and blood vessels (arteries in red; veins in blue). (d) The 3D model made by the 3D printer for further planning of the operation. The tumor mass is marked with a yellow circle. (e) We performed preoperative simulation of cutting 1cm around the lesion, including parts of the maxilla and the nasal septum, by the touch-screen interface digital modeling system. The area to be resected is marked with a dotted line circle. (f) In actual surgery, the tumor was resected successfully as planned (dotted-line circle). (g) The nodular lesion of DFSP from the left thigh to the groin. (h) MRI images reveal that the tumor is close to the great saphenous vein. (i, j) From thin slices of contrast CT images of the patient's lesion, both a virtual 3D model (i) and a printed 3D model (j) of the tumor, the femoral artery and vein, and the great saphenous vein are created. (k) Using the 3D model, we performed preoperative simulation of an operation to resect 2cm around the lesion, including the great saphenous vein (dotted-line circle). (l) The actual surgery was conducted successfully as simulated and planned. The resected area is marked with a dotted-line circle.

166x123mm (300 x 300 DPI)