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A novel computer-aided design/computer-aided manufacturing guide for reduction with advancement genioplasty

KEYWORDS
Genioplasty;
Computer-aided design;
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Genioplasty is highly customizable, and surgeons can adjust the chin in multiple directions based on the patient's goals and facial structure.[1] However, accurate pre-surgical simulation and intraoperative positioning of the chin bone segment remain challenging.[2–5]

Herein, we presented a case of a 21-year-old Japanese female who underwent bilateral sagittal ramus osteotomy for mandibular retrognathia and subsequent genioplasty and plate removal 1 year later. The patient wished for a reduction with chin advancement. Using ProPlan CMF 3.0.1 (Materialise, Leuven, Belgium), a 3D-based surgical simulation of the procedure was performed, planning for a 7.89-mm forward and 2.41-mm upward movement of the pogonion (Fig. 1A). Within the software, two cutting guides (CG-1 and CG-2) for indicating chin bone cutting and reduction, a positioning guide (PG) for holding the chin bone segment during plate fixation, and a drilling guide (DG) for securing the CGs and PG in the exact position were designed (Fig. 1B, C, D, E, F and G). These computer-aided design/computer-aided manufacturing (CAD/CAM) guides were fabricated using TrinDy DT-SG-160 surgical resin (Phrozen Technology, Hsinchu, Taiwan). Genioplasty was performed using SuperFIXSORB-MX (Osteotrans-MX; Teijin Medical Technologies Co., Ltd, Osaka, Japan), an absorbable composite comprising fine unsintered hydroxyapatite particles and carbonated ions combined with poly L-lactic acid. After drilling in the appropriate location by using the DG, temporary fixation screws (8-mm length) were used to secure the CGs and PG (Fig. 1H, I, J and K). A 3-mm-wide piece of chin bone was resected by using two CGs (Fig. 1I). Two SuperFixsorb-MX chin plates (12.6 × 10.6 mm length, 1.0-mm thickness, 8-mm step size) and eight screws (2-mm diameter, 6-mm length) were used for fixation while the chin segment was fixed using the PG (Fig. 1J and K). Finally, the PG was removed following plate fixation and the geniohyoid muscle was pulled with 4–0 absorbable thread and suture-fixed to the chin segment using screw holes for CAD/CAM guides (Fig. 1L). Computed tomography performed 10 days postoperatively revealed accurate overlay of the virtual mandible surface from the preoperative simulation, confirming successful chin osteotomy with and fixation (Fig. 1M).

Traditional genioplasty guides often consist of a CG and PG, which are designed with a tooth-borne splint that serve as a locking mechanism for accurate positioning.[2,3,5] Metal-based guides, while providing comparable precision,[4] can be costly and time-consuming to fabricate. Our proposed guides offer several advantages. First, by eliminating the tooth-borne component, preoperative dental scans and fusion can be avoided. Second, the DG was designed to fit a wide area of the bone surface, ensuring accurate fixation of the CGs and PG using four screw holes. The CG thickness of approximately 8 mm allowed for precise determination of the bone cut position and angle. Furthermore, the smaller

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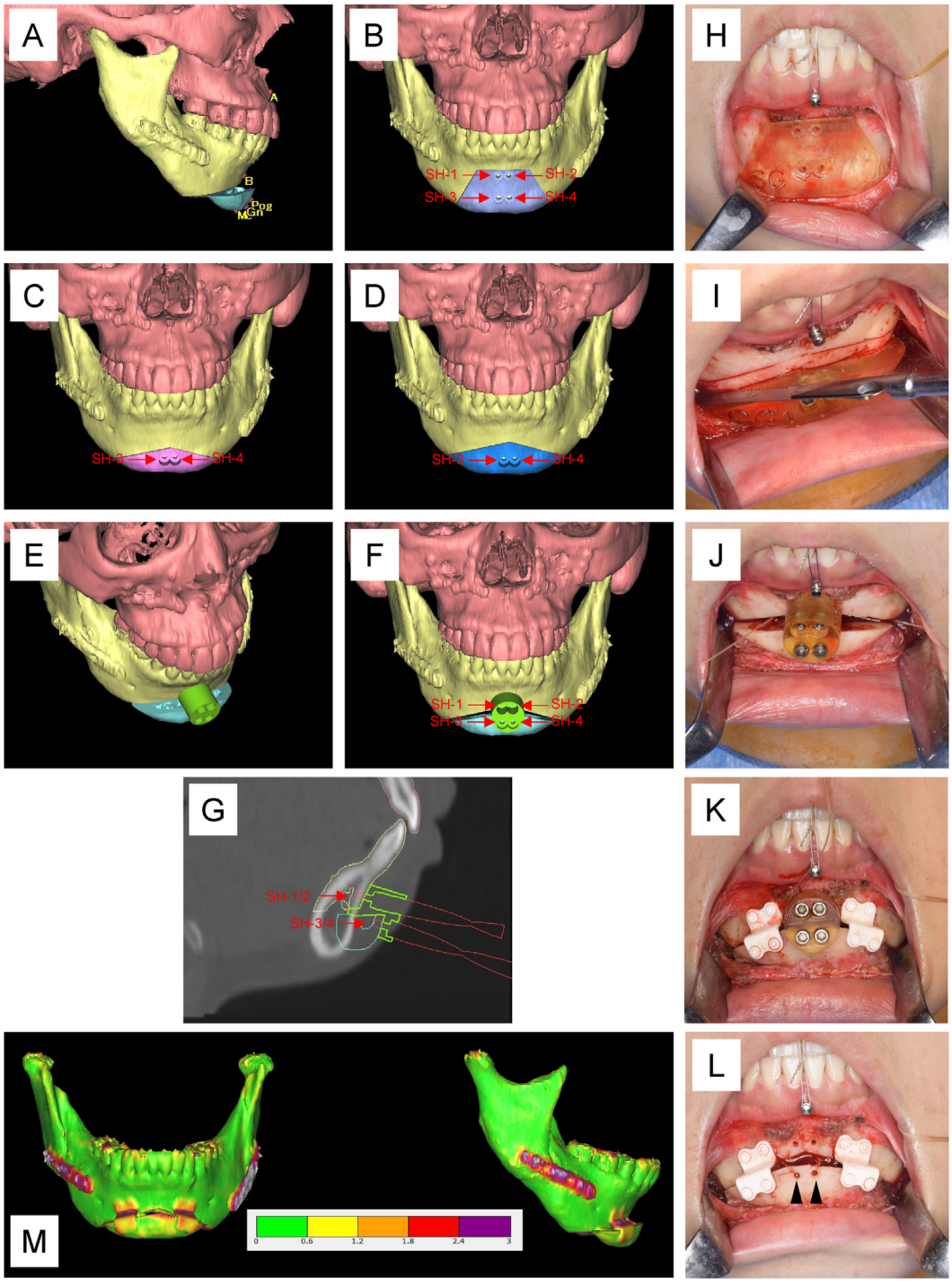

Figure 1 The computed tomography (CT) images and clinical photographs of our patient. (A) Chin bone segment movement during preoperative simulation. (B)—(G) Computer-aided design/computer-aided manufacturing (CAD/CAM) guides designed in ProPlan CMF 3.0.1. Screw holes (SHs) 1—4 were shown in red arrows. (B) Light purple: drilling guide (DG). (C) Pink: cutting guide (CG)-1. (D) Blue: CG-2. (E) ~ (G) Green: positioning guide (PG), light blue: planned position of the chin bone segment [(E) view from diagonally above right, (F) view from the front and (G) view of sagittal plane]. (H) ~ (L) Intraoperative photographs were shown. (H) Drilling in the appropriate location using the DG and forming SHs 1—4. (I) CGs were secured using temporary SuperFixsorb-MX fixation screws and SHs 3—4. A 3-mm-wide chin bone piece was resected by cutting according to the CGs. (J) The PG was fixed using temporary fixation screws and SHs 1—4 to position the chin bone segment in the planned position. (K) While keeping the PG secured, the SuperFixsorb-MX chin plate and screws were fixed. (L) The PG was removed following successful fixation and the geniohyoid muscle was suture-fixed to the chin segment using SHs 3—4 (shown in black arrow heads). (M) Surface overlay of the virtual mandible from the preoperative simulation was observed on postoperative CT. (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

size of our PG compared to the tooth-borne type guides may facilitate highly accurate fixation in a wide surgical field. These innovative design features make our novel CAD/CAM guides a valuable tool for genioplasty.

Declaration of competing interest

The authors have no conflicts of interest relevant to this article.

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