OPEN

PRS GLOBAL OPEN

CASE REPORT
Craniofacial/Pediatric

Central Mandibular Reconstruction by Semiopen Wedge Osteotomy Double-barrel Fibula Flap for a Slim Aesthetic Appearance

Itaru Tsuge, MD, PhD
Hiroki Yamanaka, MD, PhD
Motoki Katsube, MD, PhD
Yoshihiro Sowa, MD, PhD
Michiharu Sakamoto, MD, PhD
Naoki Morimoto, MD, PhD

Summary: Mandibular reconstruction involving the central segment after malignant tumor resection requires the achievement of both functional and aesthetic quality. Three-dimensional reproduction based on the concept of a double arc composed of a marginal arc and an occlusal arc is important. Most reports of fibula flaps applied three-segmented closed wedge fibula osteotomy (bilateral and central segments); however, the aesthetic outcome sometimes became too stout for female patients because of the large central segment. We performed four-segmented fibula osteotomy for a 78-year-old woman using a semiopen wedge technique characterized by a half-open wedge and half-closed wedge. This procedure obtained a slim mandibular contour and made double-barrel reconstruction easier to apply. We used titanium plates that were prebent according to the shape of a three-dimensional model constructed from CT data. Small bone cortex fragments made from a surplus fibula segment were inserted in a half-opened area. The build-up preparation for central mandibular reconstruction was all performed at the lower leg area before cutting the peroneal pedicle. This prefabricated double-barrel fibula free flap was transferred to the mandibular defect with arterial and venous anastomosis to the right superior thyroid artery, right external jugular vein, and right common facial vein. Although the patient was nearly 80 years of age, the bone segments, including free cortex tips, were fused with smooth remodeling. Semiopen wedge osteotomy can be a key to reproducing an aesthetically slim feminine chin with a functional height of mandibular bone maintained for stability of the dental prosthesis. *(Plast Reconstr Surg Glob Open 2022; 10:e4716; doi: 10.1097/GOX.0000000000004716; Published online 22 December 2022.)*

Central mandibular reconstruction after malignant tumor resection is challenging. The free fibula flap is a workhorse for complex mandibular defects. Most reports showed central part reconstruction using three-segmented closed wedge fibula osteotomy, for which construction with bilateral segments and a central segment was planned.[1–3] However, the central segment sometimes appears too stout, especially in female patients. Satisfaction with the aesthetic outcome of mandibular reconstruction with fibula flaps is reportedly much lower in women.[4] Although a double-barrel fibular flap is an excellent choice for three-dimensional reconstruction, based on the concept of a double arc composed of a marginal arc and an occlusal arc,[5] multiple osteotomies and complex build-up made central mandibular reconstruction difficult.

We applied a four-segmented double-barrel fibular flap technique for central mandibular reconstruction for a 78-year-old female patient. The key was "semiopen" wedge osteotomy, which was characterized as a half-open wedge and half-closed wedge. This surgical method solved the two difficulties: (1) it resulted in a slim feminine chin (avoiding the stout impression caused by the central bone segment) and (2) it made it easy to form the occlusal arc from another two segments because the marginal arc required only two segments. This central mandibular reconstruction method can achieve acceptable functional and aesthetic outcomes, even in older patients.

From the Department of Plastic and Reconstructive Surgery, Graduate School of Medicine, Kyoto University, Kyoto, Japan.

Received for publication September 1, 2022; accepted October 26, 2022.

DOI: 10.1097/GOX.0000000000004716

Disclosure: *The authors have no financial interest to declare in relation to the content of this article.*

Related Digital Media are available in the full-text version of the article on www.PRSGlobalOpen.com.

CASE REPORT

The patient was a 78-year-old woman with a history of hypertension, hyperlipidemia, and diabetes, who noticed a mandibular gingival tumor from the right second incisor to right second premolar one month previously. Squamous cell carcinoma (cT4N0M0) was diagnosed after the examination of a biopsy specimen. Central mandibular resection from the area between the right second molar and left second premolar was planned by otolaryngologists. Although the patient was 78 years of age, she still had many maxillary teeth, and hoped for functionally and aesthetically high-quality reconstruction.

Preoperatively, we ordered the construction of a three-dimensional mandibular model (Cross Medical, Kyoto, Japan) using computed tomography (CT) data. We bent a 2-mm-thick titanium plate (Matrix mandible angle reconstruction plate; Johnson and Johnson, NJ, USA) according to the model. First, a right fibula osteocutaneous flap was elevated using a tourniquet at the right thigh. We found two perforators to the skin. Fibula osteotomy was performed as follows: 10-cm distal to the fibula head and 6-cm proximal to the lateral malleolus. A 15-cm fibula osteocutaneous flap with the right peroneal artery and veins was prepared. With blood flow maintained, a 3.5-cm proximal bone was resected (segment 0) and 11.5 cm was made into four pieces (segments 1–4: sizes 4, 2.5, 2, and 3 cm, respectively). The skin flap area was 12 × 6 cm. A proximal 6 × 5 cm skin flap was planned to replace the oral and gingival mucosa, and the distal part was de-epithelialized (Fig. 1).

Next, the cut ends of the four fragments were crafted as semiopen wedge osteotomy with the intention of removing 40–45 degrees from the interior half of the stump. Then, bone segments 1 and 2 were fixed with 2.4-mm locking screws monocortically to the prebent 2-mm-thick titanium reconstruction plate. Bone segments 3 and 4 were folded back with vascularization by peroneal vessels and successive periosteum, and fixed with 2.0-mm locking screws monocortically to 1-mm-thick titanium trauma plates (Matrix mandible tension band plate; Johnson and Johnson). Bone segments 1 and 2 reconstructed a marginal arc, and segments 3 and 4 reconstructed an occlusal arc. Small bone fragments were crafted from the removed bone (segment 0), and buried to the gaps at the half-opened osteotomy. Absorbable threads (4-0PDS; Johnson and Johnson) were hung on the titanium plates to make fences to keep the small bone fragments in position (Fig. 2).

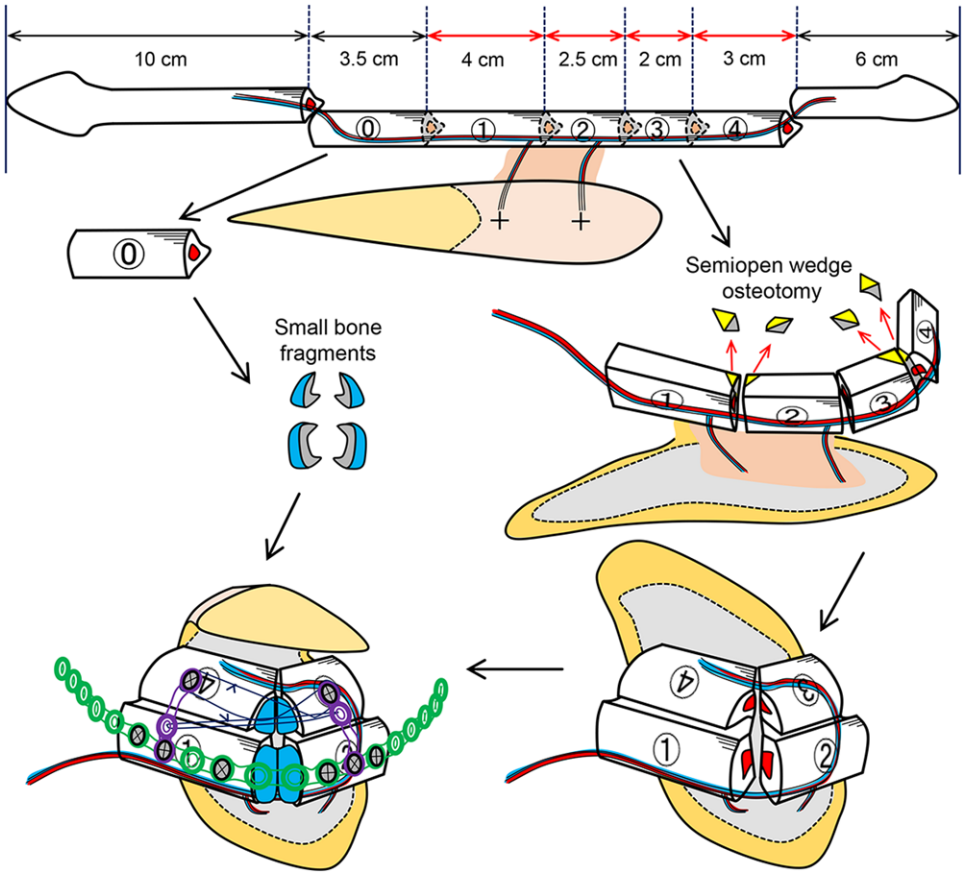

Fig. 1. Details of the double-barrel method of semiopen wedge osteotomy for a central mandibular defect. Segments 1 and 2 were for the marginal arch, and segments 3 and 4 were for the occlusal arc. All four segments were kept vascularized. Segment 0 was removed to obtain the length of peroneal artery and vein as a pedicle. Small bone pieces were made from segment 0, and the build-up was all performed in the lower leg surgical field in a prefabricated manner.

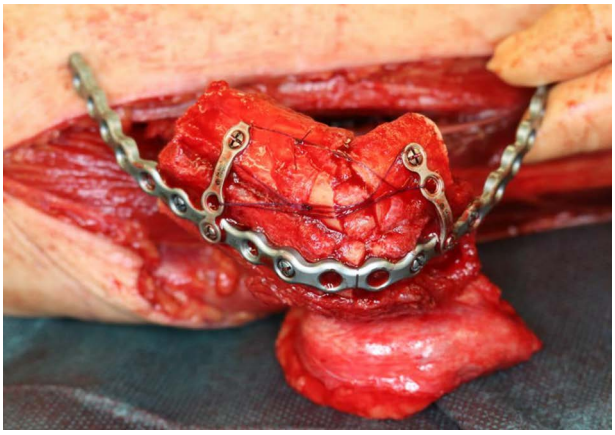

Fig. 2. Intraoperative view of a prefabricated double-barrel fibular flap for a central mandibular defect.

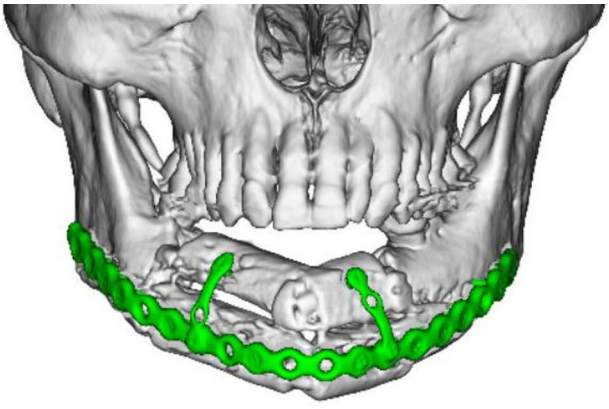

Fig. 3. Three-dimensional CT findings at 3 months postoperative.

After tumor resection and bilateral neck dissection by otolaryngologists, the skin flap was sutured to the mucosal defect. The prefabricated double-barrel fibula was fixed to residual mandibular bone bi-cortically using 2.4-mm locking screws. The peroneal artery and two peroneal veins were microscopically anastomosed to the right superior thyroid artery, right common facial vein, and right external jugular vein using 10-0 Nylon. The total operative time was 13 hours, 19 minutes. The ischemic time of the fibula flap was 71 minutes.

The pathological diagnosis was squamous cell carcinoma, pT4N0M0. No adjuvant radiation and chemotherapy were needed. Postoperative CT showed no detached screws or broken plates (Fig. 3). In 2 years, a fistula from the right chin to the oral mucosa was found. All titanium plates were removed to prevent infection. Intraoperatively, we found excellent adhesion and remodeling of transferred bones (Fig. 4). The patient was satisfied with the aesthetic and functional outcomes. The height of the occlusal arch by the double-barrel matched to use a removable denture prosthesis stably. (**See figure, Supplemental Digital Content 1**, which shows the appearance with denture at postoperative year 2, **http://links.lww.com/PRSGO/C310.**)

Fig. 4. Postoperative three-dimensional CT findings at 2 years after removal of the titanium plates.

DISCUSSION

Virtual surgical planning is often used in mandibular reconstruction using fibular flaps.[6] Computer-aided planning can precisely define lines to cut bone; however, osteotomy is performed with the closed wedge method to accurately fit the cross-sections. Double-barreling can also be planned using computer-assisted virtual planning[7]; however, excellent functional and aesthetic results are still difficult to obtain by central mandible reconstruction. We applied a four-segmented double-barrel fibular flap technique for central mandibular reconstruction using "semi-open" wedge osteotomy to make the interior half of bone segments contact to provide rigidity, and the exterior half of bone segments open to avoid a pointed contour at the chin. Nonvascular bone fragments were small enough for remodeling with adjacent vascularized fibular segments.[8] Jacobson et al[9] also reported a central mandibular reconstruction using a four-segmented double-barrel fibula flap; however, three segments were used for a marginal arc and only one segment for an occlusal arc, which resulted in bilateral bone gap at the reconstructed occlusal arc. Our surgical method can become the solution of this problem.

Hölzle et al[4] reported that two-thirds of female patients felt unsatisfied with their aesthetic appearance after central mandibular reconstruction, whereas males appeared satisfied with the aesthetic outcome. The approach could achieve double-barrel reconstruction, avoiding an excessively large chin with a masculine appearance. The difficulty of mandibular reconstruction using fibula is its straight form to change into the original curve. Most reports applied three-segmented closed wedge fibula osteotomy for central part reconstruction, but our two-segment semiopen method can propose a new choice if the original shape is a slim mandible. In 2 years, we removed titanium plates because of fistula; however, this is one advantage of autologous bone grafting over reconstruction using large plates for the aesthetic contour.[10] Adding bone fragments in semiopened bone gaps also had the possibility to influence the early adhesion and remodeling of transferred bones. Potential resorption of the distal bone segments and interference in the remodeling course

from postoperative radiotherapy are limitations of this approach.

Itaru Tsuge, MD, PhD
Department of Plastic and Reconstructive Surgery
Graduate School of Medicine, Kyoto University
54 Shogoin Kawahara-cho, Sakyou-ku
Kyoto 606-8507, Japan
E-mail: itsuge@kuhp.kyoto-u.ac.jp

REFERENCES

1. Chen J, Zhang R, Liang Y, et al. Deviation analyses of computer-assisted, template-guided mandibular reconstruction with combined osteotomy and reconstruction pre-shaped plate position technology: a comparative study. *Front Oncol.* 2021;11:719466.
2. Antúnez-Conde R, Salmerón JI, Díez-Montiel A, et al. Mandibular reconstruction with fibula flap and dental implants through virtual surgical planning and three different techniques: double-barrel flap, implant dynamic navigation and CAD/CAM mesh with iliac crest graft. *Front Oncol.* 2021;11:719712.
3. Muraru I, Muraru D, Marinescu BM, et al. Ramus to ramus mandibular defect reconstruction with osteocutaneous fibula free flap—case presentation. *Maedica* 2020;15:401–408.
4. Hölzle F, Kesting MR, Hölzle G, et al. Clinical outcome and patient satisfaction after mandibular reconstruction with free fibula flaps. *Int J Oral Maxillofac Surg.* 2007;36:802–806.
5. Sarukawa S, Noguchi T, Kamochi H, et al. Mandibular reconstruction based on the concept of double arc reconstruction. *J Craniofac Surg.* 2015;26:e539–e542.
6. Lee ZH, Alfonso AR, Ramly EP, et al. The latest evolution in virtual surgical planning: customized reconstruction plates in free fibula flap mandibular reconstruction. *Plast Reconstr Surg.* 2020;146:872–879.
7. Avraham T, Franco P, Brecht LE, et al. Functional outcomes of virtually planned free fibula flap reconstruction of the mandible. *Plast Reconstr Surg.* 2014;134:628e–634e.
8. Devireddy SK, Senthil Murugan M, Kishore Kumar RV, et al. Evaluation of non-vascular fibula graft for mandibular reconstruction. *J Maxillofac Oral Surg* 2015;14:299–307.
9. Jacobson AS, Alpert E, Persky M, et al. Transoral mandibulectomy and double barrel fibular flap reconstruction. *Laryngoscope* 2015;125:2119–2122.
10. Tarsitano A, Battaglia S, Corinaldesi G, et al. Mandibular reconstruction using a new design for a patient-specific plate to support a fibular free flap and avoid double-barrel technique. *Acta Otorhinolaryngol Ital.* 2021;41:230–235.