

The “Origami” Composite Free Fibula Flap for Complex Defects of the Mandible, Floor of the Mouth, and Tongue

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Purpose: The fibula flap serves as the workhorse for many mandibular defect types. For massive defects that include the mandible, floor of the mouth, and tongue, reconstruction might mandate a 2-flap approach. This report describes a systematic yet flexible design of a single composite osseocutaneous fibula flap for such cases.

Patients and Methods: From 2003 through 2011, 5 patients underwent surgery for T4 squamous cell carcinoma and adenoid cystic carcinoma. They underwent wide resection of the mandible and floor of the mouth with hemi- to subtotal glossectomy. A large skin paddle was designed on the leg using a customized template consisting of 3 components matching the alveolar, floor-of-mouth, and tongue segments. The round tongue component was folded using its thickness to provide 3-dimensional volume and form in place of the missing tongue. The other 2 components had a crescent shape and were adjusted intraoperatively to match the resected defect.

Results: All 5 flaps survived, with 1 case of flap loss that was successfully replaced. Delayed healing of the leg donor site was encountered in 4 patients.

Conclusion: The proposed single 3-dimensionally folded flap design provides ample tissue to replace bony and soft tissue elements for major anterior or lateral segment defects. There was morbidity owing to donor-site complications but these were treatable, with recorded functional restoration.

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The fibular flap is widely accepted as the mainstay of repair of various mandibular defect types. Although plate-based reconstruction of the mandible is an option in specific cases,¹ most large lateral and anterior mandibular segment defects require bony reconstruction.²

The fibula was first recognized as a vascularized flap for long bone reconstruction in 1975 by Taylor et al.³

Subsequently, Hidalgo⁴ in 1989 reported adapting the flap to mandibular reconstruction, showing that the bone could be safely osteotomized multiple times to simulate the refined nuances of the mandible's shape. It has been shown that 25 cm of useful fibular length provides sufficient bone stock to reconstruct major mandibular defects. Furthermore, the

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dimensions of the fibula have been shown to adequately support the use of osseointegrated implants.⁵ Large skin paddles based on distal septocutaneous perforators can be reliably harvested with the fibular bone.⁶ The fibula flap also can be harvested to include the flexor hallucis longus and soleus muscles to provide additional flap bulk.⁷

The outstanding qualities of the fibula as a donor site make it the first choice for most mandibular defects. In complex mandibular defects, a single scapular flap can provide the soft tissue needed for reconstruction, but the limited bone size, quality, and location make it less suitable than the alternative of using 2 separate flaps.⁸ Complex defects, which involve the loss of a large volume of soft tissue, including the tongue, floor of the mouth, and alveolar intraoral regions, in addition to the bony defect, often require a second free flap.^{9,10} In such cases, a second flap provides adequate tissue and an ease of flap inset. Usually the fibula is combined with the radial forearm fasciocutaneous flap for this application. Other flap combinations have been used, including fibula and rectus femoris, fibula and tensor fascia lata, iliac crest and radial forearm, and iliac crest and tensor fascia lata flaps.¹¹

The authors report on their experience treating complex tongue resections with adjacent soft tissue and mandibular defects. Their approach to such defects is based on a single folded composite osseocutaneous fibula flap. The fibular skin paddle is designed according to a template to promote a customized inset and maximize its volume. The bony component of the flap is used to bridge the mandibular gap as required.

Patients and Methods

In this retrospective case series, the authors collected and reviewed the files of 5 patients requiring major composite resection of the mandible and tongue. Patients were treated from 2003 through 2011. Their ages ranged from 34 to 63 years (median, 50.8 years). The authors' institutional review committee approved the study protocol.

Three patients underwent surgery for T4 squamous cell carcinoma (SCC), 1 for T4 adenoid cystic carcinoma (ACC), and 1 for recurrent ACC (Table 1). All patients underwent wide complex resections of the anterior or lateral mandible, including large areas of the floor of the mouth with hemi- to subtotal glossectomy. Three patients underwent bilateral modified neck dissection (ND), and 1 patient underwent left selective and right modified ND. One patient had undergone a right modified ND 1 year before the complex resection as part of a primary tumor ablation procedure (Table 2). Radiotherapy was administered preoperatively to 2 patients and postoperatively to 3. As part of the authors' proto-

col, intraoperative tracheostomy was performed at the beginning of each procedure before ablative surgery commenced. Postoperatively, the diameter of the tracheostomy cannula progressively decreased in all patients until removal at postoperative days 10 to 14. Length of follow-up ranged from 2 months to 7 years. Patients' data, demographics, comorbidity, and pathology are presented in Table 1. Only 1 patient (case 1) had an analysis of esthetic and functional outcomes using the University of Washington Quality of Life Questionnaire version 4 (UW-QOL-4), because 2 patients died of their disease and the other 2 were lost to follow-up.

A composite osseocutaneous fibular flap was harvested based on the peroneal vessels using the lateral approach. In all patients, a large skin paddle was outlined on the patient's leg using a customized template designed by the senior author (Fig 1). This novel template design was folded to form a 3-dimensional tongue-like structure, inspired by the Japanese folding art of origami. The template, measuring up to 17 × 15 cm, was drawn across the axis of the distal fibula. The template design consisted of 3 overlapping segments designed to match the alveolar, floor-of-mouth, and tongue regions. The tongue segment was round and folded using 3 de-epithelialized triangular zones to a cone-shaped structure. De-epithelialization of only 1 or 2 triangles produced an elongated structure that could be applied to restore a hemiglossectomy defect. The other 2 components of the template had a crescent shape and were adjusted intraoperatively to restore the floor of the mouth and alveolar defects or adjacent buccal mucosa. The skin paddle was placed over the septocutaneous perforators lying along a line between the round segment and the middle crescent of the template.

The flap was prepared for transfer from the leg after skin paddle folding and bone shaping by osteotomies. The fibular segments were fixed to a pre-banded 2-mm mandibular reconstruction plate or to 1.7-mm miniplates. These fixation systems were from Leibinger (Stryker, Kalamazoo, MI). Then, vascular anastomosis and flap inset were completed.

In 2 patients, a pectoralis major muscle turnover flap was transposed to the neck and submental area to provide cervical vascular coverage and seal the neck. In 2 cases, the flap included a segment of soleus muscle, providing additional bulk to the reconstructed tongue and ensuring a neck seal. Although this flap, with or without the added soleus muscle, provides ample skin and bulk for major defects of the tongue, floor of the mouth, and mandible, occasionally the flap is insufficient and muscle flaps, whether chimeric (soleus) or local (pectoralis major), might be needed for those cases requiring more bulk or a seal between the oral cavity and the neck subcutaneous structures.

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