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Chimeric LSMAP Double-barrel Fibula Free Flap: Goal-oriented Surgical Technique and Tips for One-stage Mandibular Reconstruction

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Summary: Composite oromandibular defects involving jaw bones, intraoral and skin/soft tissues, or dynamic structures such as the tongue, soft palate, and pharynx are real reconstructive challenges even today. Despite improvements in oral dental rehabilitation, another complex task to deal with in young patients with dentate or nonatrophic mandible is correcting a too large vertical occlusal dimension, which makes the prosthodontic rehabilitation very challenging. Instead of using more complex and time-consuming methods such as simultaneous free flaps and to avoid further bone graft and second-stage revision procedures, an innovative double-barrel shaped chimeric fibula free flap with lateral supramalleolar artery perforator flap is used to fulfill all of the reconstructive requisites in one-stage. This new operative technique has never been described before. To deal with a complex head and neck reconstruction, the step-by-step harvesting technique, flap design, and inset of flap are described, giving tips and tricks to avoid jeopardizing its vascularity. A proper match between the bone transplant and native mandible, together with a sufficient amount of tissue for proper oropharyngeal reconstruction was achieved in one stage. Both the functional and aesthetic results were excellent, requiring no further revisions in a second stage. The chimeric fibula free flap with lateral supramalleolar artery perforator flap is a novel, versatile, and useful technique that provides a good opportunity for clinicians and patients to achieve adequate prosthetic rehabilitation and improved aesthetics in reconstruction of postablative extensive oromandibular defects in one stage.
(Plast Reconstr Surg Glob Open 2022;10:e4040; doi: 10.1097/GOX.0000000000004040; Published online 25 January 2022.)

The first lower-jaw reconstruction with a fibular flap, using osteotomies to mimic the shape of the mandible, was described in 1989 by Hidalgo.[1] Since then the fibular free flap (FFF) has become the workhorse of mandibular reconstruction. Although the skin island of the osteocutaneous FFF may be adequate for the coverage of both the inner lining and outer face in oromandibular defects, it is often inadequate for replacement of soft tissue volume in composite defects. Several solutions have been proposed to overcome these problems, including simultaneous double free-flap.[2] More recently, thanks to further advances in knowledge of vascular anatomy and improvement of technique, free tissue transfers based on chimeric principles[3,4] have been used in head and neck reconstructions.

In 2003 Domingo Sicilia-Castro et al[5] first reported the combined use of a fibula osteomyocutaneous free flap with a fasciocutaneous lateral supramalleolar paddle as a chimeric flap. This type of flap provides an adequate bone stock together with a cutaneous fibular paddle and a second truly independent supramalleolar skin paddle, all with a single set of microanastomosis. Later, Massarelli et al[6] gave strong evidence in the literature of its feasibility and successful reliability in 3D-reconstruction of composite head and neck defects and gave it the current denomination of chimeric lateral supramalleolar artery perforator fibula free flap (chimeric LSMAP FFF).

However, the already well-known main disadvantage of the fibular graft is its small circumference, which makes

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Received for publication August 21, 2021; accepted November 10, 2021.

DOI: 10.1097/GOX.0000000000004040

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

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for a challenging reconstructive task to overcome the significant difference in height between the reconstructed mandible and intact maxillary alveolar ridge for adequate dental rehabilitation in young patients with dentate or nonatrophic mandible. The inadequate height of the reconstructive segments creates a large vertical dimension between the occlusal planes, which is difficult to fill with the prosthetic device alone. This evokes high leverage forces, which can cause overload of the osseointegrated implants and compromise the longevity of the prosthetic restoration.

Horiuchi et al[7] in 1995 demonstrated that double-barreled modeling can be a technical improvement to correctly restore the neo-mandible bone thickness and popularized its use.

In this article we introduce the chimeric LSMAP double-barrel FFF, which has not been previously reported in the literature, as a novel one-stage method for composite lateral head and neck reconstructions involving mandibular bone, intraoral soft tissues, hard palate and tonsillar fossa, describing its technique step-by-step and giving tips and tricks for not jeopardizing its vascularity.

Takeaways

Question: How to three-dimensionally manage challenging reconstructions of composite lateral head and neck defects involving intraoral and pharyngeal soft tissues and mandibular bone in young and dentate patients?

Findings: We describe a reliable step-by-step double-barrel modeling technique of the chimeric lateral supramalleolar artery perforator fibula free flap (chimeric LSMAP FFF), including design and flap insetting, and provide tips and tricks for not jeopardizing its vascularity. This chimeric LSMAP double-barrel FFF has proven to allow a one-stage composite lateral oro-pharyngeal and mandibular reconstructions, providing a reliable bone hardware to secondary implant surgery for long-lasting dental rehabilitation.

Meaning: New chimeric LSMAP double-barrel fibula free flap.

SURGICAL TECHNIQUE

This study was conducted following the ethical principles of the Declaration of Helsinki (version 2002). In June 2009, a 63-year-old White male patient with dentate jaws was referred to me for left retromolar trigone squamous cell carcinoma, which involved the ascending branch, the buccal mucosa, the tuber maxillae, the tonsillar fossa, and part of the hard palate. The inevitable disadvantages of single osteocutaneous FFF and those of simultaneous free flap harvesting were discussed.

To obtain the full complex reconstruction in one-stage and offer the opportunity to perform a dental rehabilitation on implant-supported prosthesis secondarily, a chimeric LSMAP FFF modeled in a double-barrel way was planned. MRI-angiography of the tibial and peroneal vessels of both lower limbs showed adequate vascular anatomy, but the right leg was chosen as the donor site. In fact, to allow the fibular skin to fall inside to reconstruct the left intraoral mucosal defect and for the vascular pedicle to properly exit from the posterior aspect of the neo-mandibular left angle, the proper flap orientation required is that the whole transplant be turned by 180 degrees.[8] The septocutaneous perforating branches that feed the proximal fibula skin paddle, and the distal LSMAP flap were located with Doppler study. The perforator position that feeds the fibular skin paddle relative to the bone shaft is crucial. The primary skin paddle should be designed over the distal septocutaneous perforators, always centered on the segment that will reconstruct the basal mandible or closest to the one that will be removed,[9] so that once this has been removed, the skin paddle can have the best rotational pivot and can fall inward of the oral cavity without jeopardizing its vascularity (Fig. 1).

A fibular skin paddle of 11 × 4 cm and an LSMAP flap of 8 × 4 cm were drawn, both centered on the identified perforating branches, and tailored to properly fill the defect. The fibular skin paddle was planned for the intraoral soft tissue defect reconstruction and LSMAP for the oropharyngeal one. The flap was harvested using the usual technique[6] (Fig. 2).

The double-barrel shaping shown in Supplemental Digital Content 1 demonstrates a step-by-step surgical modeling for a proper insetting technique. (**See figure, Supplemental Digital Content 1,** which shows a double-barrel bone modeling and a proper insetting of soft tissue portions of flap. Upper-left: Paper template of the chimeric LSMAP FFF in anatomic position in the right leg in which linear and wedge ostectomies (for mandibular resection and fibular segmentation) have been already planned; Upper-right: The flap tilted clockwise at 180 degrees with respect to its original position; Center-left: The B and D-segments were discarted to allow proper apposition and rotation of the other fragments; Center-right: A and C-segments juxtaposed; Lower-left: The distal segment (segment E) is freed to rotate upwards and be positioned above the segment C in double-barrel way;

Fig. 1. The proper perforator skin paddles position relative to the bone shaft is crucial for allowing the best rotational pivot and to not jeopardize its vascularity. "S": Bone Segment; "A-B-C-D-E": multiple peroneal bone segments, which will be osteotomized as explained in the text and shown **Supplemental Digital Content 1** (http://links.lww.com/PRSGO/B899), to obtain a double-barrel reconstruction of the body and mandibular ramus.

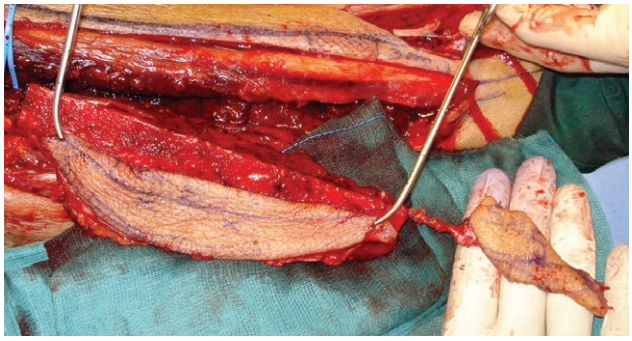

Fig. 2. The full-harvested Chimeric LSMAP FFF showing the two independent skin paddles in flow-through arranged.

Lower-right: The chimeric LSMAP FFF fully harvested. P: proximal; D: distal. **http://links.lww.com/PRSGO/B899**.)

A 17-cm-long bone was raised (SDC 1, upper-left). Six osteotomies, four of which were linear and two of which were wedge, were performed after rotating the transplant clockwise by 180 degrees (upper-right). Five segments (S) were achieved as follows: SA, 3 cm; SB, 2 cm (measured at level of the inferior border) triangular shaped; SC, 5.5 cm; SD, 2 cm; SE, 4.5 cm (center-left). The most proximal (related to the peroneal pedicle) SA was placed to reconstruct the lower part of left mandibular ascending ramus. The SB was removed subperiosteally and discarded to help a proper mandibular angle shape. The SC was placed along the lower border of the mandible and together with the first forms the mandibular angle of 240 degrees[10] (center-right). The SD was removed subperiosteally and discarded to prevent stretching or compressing the vascular bundle, leaving the periosteum intact between the SC and E, allowing a safe rotation of the latter (lower-left). Finally the SE was rotated upward and placed over the lower border of the mandible parallel to SC to reconstruct the upper part of alveolar ridge of the mandible body, which served as the osteointegrated teeth carrier (lower-right). The bone fragments were fixed, and a good neomandible shaping was restablished (Fig. 3). The end-to-end microanastomosis was performed in the left recipient vessels (Fig. 4).

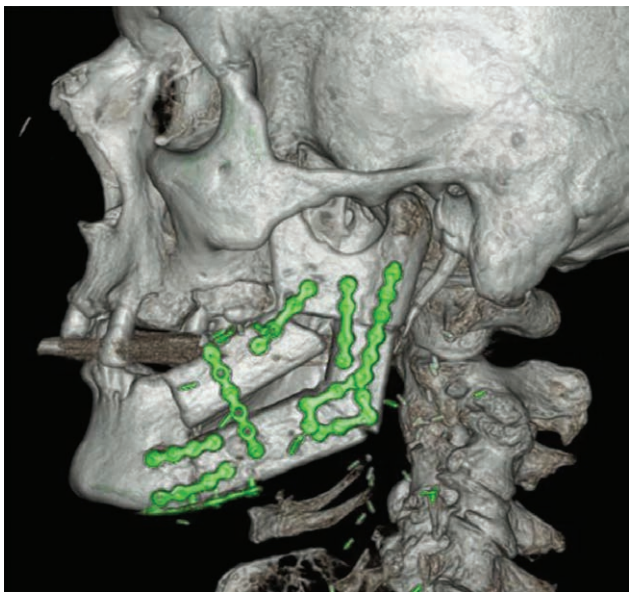

Fig. 3. Good neomandible shaping is reestablished and bone fragments are fixed.

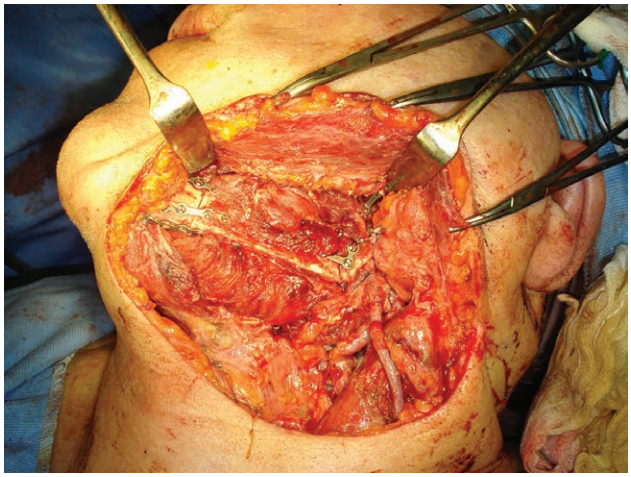

Fig. 4. The vascular pedicle exits from the posterior aspect of the neomandible at an angle and the microanastomosis is performed.

CONCLUSIONS

This report illustrates how the chimeric LSMAP FFF is safely modeled into a double-barrel shape, providing a reliable bone hardware for further dental rehabilitation, together with a sufficient amount of soft tissues to achieve one-stage composite lateral head and neck reconstructions. This technique can be a useful tool for surgical armamentarium for head and neck surgeons.

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ACKNOWLEDGMENTS

The author thanks Meloni Silvio Mario, DDS, Assistant Professor School of Dentistry, University of Sassari, Viale San Pietro 43/B, Sassari 07100, Italy and Private Practice, 07021 Arzachena, Italy, for having rehabilitated the patient on a fixed implant-supported prosthesis. Due to its retrospective nature, this study did not require ethical committee approval. Written informed consent for publication of clinical details and/or clinical images was obtained from the patient.

REFERENCES

1. Hidalgo DA. Fibula free flap: a new method of mandible reconstruction. *Plast Reconstr Surg.* 1989;84:71–79.

2. Wei FC, Demirkan F, Chen HC, et al. Double free flaps in reconstruction of extensive composite mandibular defects in head and neck cancer. *Plast Reconstr Surg.* 1999;103:39–47.
3. Hallock GG. Simultaneous transposition of anterior thigh muscle and fascia flaps: an introduction to the chimera flap principle. *Ann Plast Surg.* 1991;27:126–131.
4. Liu WC, Yang KC. One-stage through-and-through cheek, lips, and oral commissure reconstruction using a double-paddle peroneal chimeric flap: an innovative method. *Head Neck.* 2015;37:662–669.
5. Sicilia-Castro D, Garcia-Perla A, Infante-Cossio P, et al. Combined fibula osteoseptocutaneous-lateral supramalleolar flap for reconstruction of composite mandibular defects. *Plast Reconstr Surg.* 2003;111:2003–2008.
6. Massarelli O, Gobbi R, Biglio A, et al. Chimeric lateral supramalleolar artery perforator fibula free flap in the reconstruction of composite head and neck defects. *Plast Reconstr Surg.* 2014;133:130–136.
7. Horiuchi K, Hattori A, Inada I, et al. Mandibular reconstruction using the double barrel fibular graft. *Microsurgery.* 1995;16:450–454.
8. Urken ML, Futran N. Fibular Osteocutaneous flap inset techniques. In: Urken ML, Cheney ML, Blackwell KE, Harris JR, Hadlock TA, Futran N, eds. *Atlas of Regional and Free Flaps For Head and Neck Reconstruction.* 2nd ed. Philadelphia, Pa.: Lippincott Williams & Wilkins; 2012:419–420.
9. Yu P, Chang EI, Hanasono MM. Design of a reliable skin paddle for the fibula osteocutaneous flap: perforator anatomy revisited. *Plast Reconstr Surg.* 2011;128:440–446.
10. Nobis CP, Kesting MR, Wolff KD, et al. Development of a template tool for facilitating fibula osteotomy in reconstruction of mandibular defects by digital analysis of the human mandible. *Clin Oral Investig.* 2020;24:3077–3083.