Lower Lip Reconstruction Using a Functioning Gracilis Muscle Free Flap

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ABSTRACT

The lips are highly visible structures on the face, providing oral competence and expressing emotion. The reconstruction of large full-thickness defects of the lips is a formidable challenge for the plastic surgeon. The most challenging defect of the lower lip is full thickness, larger than two thirds. Such an extensive defect requires either staged reconstruction or a flap of distant tissue. We consider that the gracilis muscle, due to its anatomic and functional features, is the ideal flap for reconstruction of the lips. A functioning gracilis matches all the requisites and allows normal movements that are uniform to all of the lip. The new commissure is symmetric and moves simultaneously with the residual commissure due to innervation by the facial nerve. Our indications to use the functioning gracilis muscle flap in lip reconstruction are as follows: resection of the lower lip larger than one quarter of the lip length in a patient younger than 60 years; resection larger than one third of the lip in all patients. When performing a free gracilis flap for lip reconstruction, we consider that, if possible, a facial artery musculomucosal flap and sensitive neurotization should be included to restore sensation of the reconstructed lip.

KEYWORDS: Facial artery musculomucosal flap, gracilis muscle free flap, lower lip

The gracilis muscle is a well-known free flap in reconstructive surgery for repairing different kinds of defects, such as facial palsy, total tongue reconstruction, muscle replacement in the upper limb, and several soft tissue repairs.¹ The gracilis muscle, due to its anatomic and functional features, is also the ideal flap for lip reconstruction.^{2,3} The lips are highly visible structures on the face and serve important and diverse functions such as articulation, mastication, provision of oral competence, and expression of emotion.

The reconstruction of large full-thickness defects of the lips continues to be a formidable challenge for the plastic surgeon as the lips symbolize beauty and appeal.⁴ The objectives of a reconstructive effort are both functional and aesthetic: approaching a normal appearance, restoring the symmetry. Reconstruction of the lower lip is the most important,⁴⁻⁶ because oral competence depends greatly on a functional lower lip having good muscular function and an adequate height and sensation. The most challenging defects of the lower lip are full

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thickness and larger than two thirds of the lip; such extensive defects require either staged reconstruction or a flap of distant tissue.

A functioning gracilis flap matches all the requirements and allows normal movements that are uniform to the whole lip. The new commissure is symmetric and moves simultaneously with the residual commissure due to innervation by the facial nerve.

Our indications for using the functioning gracilis muscle flap in lip reconstruction are as follows:

1. Resection of the lower lip larger than one quarter of the lip length in a patient younger than 60 years.
2. Resection larger than one third of the lip in all patients.

HISTORY OF LIP RECONSTRUCTION

In principle, the lower lip can be reconstructed using:

1. A local flap: cheek advancement flaps,⁶⁻⁹ rotation flaps using the residual lip,^{10,11} or nasolabial tissue.^{12,13}
2. A regional pedicled flap.^{6,14-16}
3. Free flaps.¹⁷⁻²⁰

There is no definitive and widely accepted way to manage large lip defects. A combination of local flaps or the use of free flaps has been reported, especially for the most extensive defects, including the mental area.^{18,21,22} All the techniques should accomplish good aesthetic/functional results, but some disadvantages are apparent, mostly regarding the final extent of lip resection and the fate of the surrounding tissues.

Local Flaps

CHEEK ADVANCEMENT FLAP

The innervated muscle-bearing flaps obtained from cheek advancement, such as the Bernard-Burow and Webster,⁷⁻⁹ are credited with maintaining sphincter function and being aesthetically pleasing; the cheeks are advanced into the lip unit with minimal facial distortion. The criticisms of this method include the inability to restore the orbicularis sphincter, although oral continence may be preserved; the reconstructed lower lip is usually tight, with a bulky upper lip⁴; and a large amount of healthy tissue in the nasolabial and chin-labial area is disregarded. Nevertheless, excellent aesthetic and functional results have been reported in older patients for the reconstruction of both upper and lower lip.²²

ROTATION FLAP USING THE RESIDUAL LIP

Gilles and Millard²³ first described the fan-flap for lower lip reconstruction; it was later modified by McGregor.¹¹

This flap can be used also for extensive reconstruction of the upper lip.⁵ Potential disadvantages are that full return of sensory/motor function cannot be demonstrated routinely; there may not be adequate muscular tissue to maintain oral competence; and microstomia may result.

Karapandzic modified the Gilles fan-flap.¹⁰ This flap preserves neurovascular structures, the lip has sensation and orbicularis function from the first postoperative day, but it changes the position of the oral commissure. Microstomia always results but rarely causes significant problems: Properly speaking and non-drooling patients rarely complain of microstomia.²⁴ The long-term results show some evidence of surgical intervention, and Jackson⁵ recommended this technique particularly for subtotal (up to three quarters) reconstruction of the lower lip.

A total lower lip reconstruction is also possible with an extended Karapandzic flap, but the microstomia is much more evident. Kroll²¹ overcame the microstomia by adding two sequential Abbe flaps and a commissure plasty, with a very good functional/aesthetic result.

CROSS-LIP FLAPS

Yoshida et al²⁵ described good aesthetic/functional results in repairing lower lip defects. Disadvantages are a two-stage operation, microstomia, and difficulty in managing extensive defects.

NASOLABIAL FLAPS

Full-thickness nasolabial flaps,¹³ often bilateral, have been used for total lower lip reconstruction, but the shift of the mouth corner may create a deformity of the upper lip, denervating the upper lip and destroying the orbicularis muscle around the commissure; it may also be difficult to attain an oral sphincter function. Often, unsightly bulging is created at the pivot point, but the recent modification of this technique overcomes the aesthetic defects, and better results have been achieved when the vertical resection of the chin was not required.²⁶ However, successful reconstruction of the total lower lip with the gate-flap technique has been reported.²⁷

GENERAL COMMENT

In our opinion, all of the above local flaps have so much more pleasant aesthetic results because much tissue laxity is present. Regarding their function and sensibility, some doubts exist.^{4,6,27}

Regional Flaps

Sternocleidomastoideus or deltopectoral flaps^{15,16} are very voluminous and require a two-stage procedure. Also, they cause bulkiness on the neck and an unpleasant appearance of the donor sites.

Free Flaps

The main advantages of a free flap are that the residual tissues are well preserved and the surgeon need not be concerned about the final amount of the tissue resection. The most performed flap for total lip reconstruction has been the radial forearm flap (RFF),^{20,28,29} for which good aesthetic and functional results have been reported. However, RFF has no motility of its own, and the color match is not ideal.⁴ The efforts to improve motility and symmetry are demonstrated by the different technical solutions for fixation of the palmaris longus tendon—looping it around the modiolus²⁹ seems the best choice—and the inclusion of some perioral muscle flap.³⁰

SURGICAL TECHNIQUE

During lip resection, a second team harvests a gracilis muscle free flap by a straight incision of the medial thigh. The average vascular pedicle length is ~6 cm, as well as the branch of the obturator nerve to the muscle.¹ The pedicle is divided after completing the dissection of the recipient vessel at the neck. The pedicle should be long enough to reach the superior thyroid vessels in the event of very extensive resection of the perioral tissue.

To perform a functioning muscle transfer, care needs to be taken to recognize the ipsilateral marginal branch of the facial nerve during the resection. The length of the lip is calculated while stressing to the maximum length of the lip before resection. Suture marking is put on the gracilis before cutting it.

The gracilis muscle flap is divided and trimmed to the required dimensions, width and length, under microscopic magnification at the side table, sparing the innervation and nourishment of the muscle subunits. The muscle is then inset, according to resting length, taking care to suture the edge of the flap to the buccinator muscle and to a bony structure. A sling of the gracilis has to be sutured with the residual opposite orbicularis muscle and passed through and looped around the residual commissural fibers, at the level of the original commissure, to reconstruct a new mouth sphincter.

In the case of resection of both commissures, when a part of the upper lip has also been removed, a longer gracilis sling maintains the continuity of the sphincter, connecting the new lower lip to the upper one.

The pedicle vessels of the flap are anastomosed to the recipient vessels, then the marginal branch of the facial nerve is anastomosed to the obturator nerve; the mental nerve, when it is possible to spare it, can be inserted into the muscle to try to innervate the gracilis. It is important to point out that when performing a free gracilis for lip reconstruction, we always consider whether it is feasible to add the Pribaz facial artery musculomucosal (FAMM) flap³¹ and sensory innervation to restore sensation at the reconstructed lip.^{32,33}

A FAMM flap at the resection step of the procedure can be prepared; it provides inner mucosa coverage of the new lip and the vermilion. The FAMM flap, according to Pribaz, can be inferiorly or superiorly based. Finally, the gracilis muscle is grafted with split-thickness skin from an area with optimal color match for the lip, such as the scalp or the supraclavicular region.

CLINICAL CASES

In a case of subtotal resection of the lip (Fig. 1), our technique allowed the symmetry of the mouth to be maintained, avoiding distortion of the residual commissure and sparing all the tissue around the lip defect. This characteristic should be a further advantage when part of the cheek also has to be removed during the resection of a larger tumor; in such a case, it is not advisable to use a cheek advancement flap.

In a case of total lip reconstruction (Fig. 2), the gracilis muscle restored completely the oral sphincter, with symmetry of the mouth and a normal opening. The adjunct of a FAMM flap allowed the inner surface of the gracilis muscle to be restored and achieve a nice, natural vermilion, due to the amount of mucosa available and the good freedom of movement of its pedicle. The FAMM flap is an axial flap, consisting of mucosa, submucosa, a small amount of buccinator muscle, the deeper plane of the orbicularis oris muscle, and the facial artery and venous plexus. The FAMM flap has the advantage of being completed in one stage compared with tongue flaps and cross-lip flaps, which require a secondary division and can be more distressing for the patient. Furthermore, our patients regained sensibility of the reconstructed lip.

On the 15th postoperative day, the patients started a program of physiotherapy to recover the labial mimic. There was drooling for a period of up 2 weeks, in the presence of muscle edema. After 1 month, the patients had no further drooling, and there were no problems with normal word articulation, mouth opening, and eating. The oral continence was perfect, without any leakage of air during puffing, due to the fact that the function of the mouth sphincter had been restored completely.

An electromyographic study should be performed every 6 months in the first year after surgery to check recovery of motor innervation, as well as a scheduled physical examination. The sensory examination includes a touch-pressure sensation test using the Semmes-Weinstein monofilament test, temperature test, and static 2-point discrimination test.

Usually, after 1 year, the patients with sensory innervation showed a regained sensibility to temperature and normal results of the test with Semmes-Weinstein monofilaments and for the cutaneous pressure threshold; the 2-point discrimination was usually between 2.5 and

Figure 1 Subtotal lip reconstruction using an innervated free gracilis muscle flap. (A) A 21-year-old man with a sclerosing basosquamous cancer of the left inner lower lip and chin. (B) Due to the aggressive nature of his cancer, the oncologic surgeon marked the extension of the lip resection. (C) Intraoperative view after full-thickness, partial lower lip resection. (D) A superiorly based FAMM flap is harvested for mucosal coverage prior to inset of the muscle flap. (E) A gracilis free flap measuring 9×6 cm is harvested in the standard fashion, divided, and trimmed to the appropriate muscle length under microscopic evaluation to preserve blood and nerve supply. (F) The gracilis muscle is inset with the appropriate resting muscle tension and sutured to the buccinator muscle laterally, the corpus mandibulae medially, and a sling of the gracilis muscle is sutured to the residual opposite orbicularis muscle. The pedicle is anastomosed to the recipient vessels and the flap neurotized as discussed in the text. (G) A split-thickness skin graft was obtained from the scalp for optimal color match. (H, I) One-year postoperative photographs. (From Ninkovic M, Spanio di Spilimbergo S, Ninkovic M. Lower lip reconstruction: introduction of a new procedure using a functioning gracilis muscle free flap. *Plastic and Reconstructive Surgery* 2007;119:1472–1480. ©Lippincott Williams & Wilkins. Reprinted by permission.)

Figure 2 Total lower lip reconstruction using an innervated free gracilis muscle flap. (A, B) A 43-year-old woman with a congenital vascular malformation of the lip and chin. (C) Intraoperative view after extensive resection of the vascular malformation encompassing the commissures bilaterally. (D) The gracilis muscle free flap measuring 17×7 cm. (E) The muscle is inset according to resting muscle tension and sutured to the upper lip's remaining orbicularis muscle to form a sphincter and a sling. The defect is closed with local tissue as well as a spit-thickness skin graft from the supraclavicular region. (F, G) Postoperative views 1 year after surgery: at rest, frontal and lateral. (H) Mouth opening with view of superior incisors. (I) Cheek "puffing" movement showing strong symmetric voluntary contraction of the lower lip. (From Ninkovic M, Spanio di Spilimbergo S, Ninkovic M. Lower lip reconstruction: introduction of a new procedure using a functioning gracilis muscle free flap. *Plastic and Reconstructive Surgery* 2007;119:1472-1480. ©Lippincott Williams & Wilkins. Reprinted by permission.)

6 mm. The motility of the reconstructed lips was normal, and the patients were really happy with the aesthetic and functional results.

COMPARISON OF THE FUNCTIONING GRACILIS MUSCLE TO ALL OTHER SOLUTIONS TO RECONSTRUCT THE LOWER LIP

Concerning local flaps, the disadvantages are clear: staged sequential procedures,^{4-6,17} excessively tight reconstructed lips,¹⁴ disregard of perioral healthy tissues, and sometimes microstomia. Above all, these procedures are unsuitable when total lip resection is performed in young patients, who do not have laxity of tissue and may be discouraged by multiple facial scars. Moreover, the free flaps commonly performed, such as the radial forearm flap, do not possess their own motility, and the color match is not ideal. Finally, donor site morbidity is evident.

Considering the technical solutions available, a functioning gracilis muscle should be considered the ideal flap to improve the functional/aesthetic outcome with minimal donor site morbidity.

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