Neurovascular Free-Muscle Transfer for the Treatment of Established Facial Paralysis following Ablative Surgery in the Parotid Region

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Neurovascular free-muscle transfer for facial reanimation was performed as a secondary reconstructive procedure for 45 patients with facial paralysis resulting from ablative surgery in the parotid region. This intervention differs from neurovascular free-muscle transfer for treatment of established facial paralysis resulting from conditions such as congenital dysfunction, unresolved Bell palsy, Hunt syndrome, or intracranial morbidity, with difficulties including selection of recipient vessels and nerves, and requirements for soft-tissue augmentation. This article describes the authors' operative procedure for neurovascular free-muscle transfer after ablative surgery in the parotid region. Gracilis muscle ($n = 24$) or latissimus dorsi muscle ($n = 21$) was used for transfer. With gracilis transfer, recipient vessels comprised the superficial temporal vessels in 12 patients and the facial vessels in 12. For latissimus dorsi transfer, recipient vessels comprised the facial vessels in 16 patients and the superior thyroid artery and superior thyroid or internal jugular vein in four. Facial vessels on the contralateral side were used with interpositional graft of radial vessels in the remaining patient with latissimus dorsi transfer. Cross-face nerve grafting was performed before muscle transfer in 22 patients undergoing gracilis transfer. In the remaining two gracilis patients, the ipsilateral facial nerve stump was used as the primary recipient nerve. Dermal fat flap overlying the gracilis muscle was used for cheek augmentation in one patient. In the other 23 patients, only the gracilis muscle was used. With latissimus dorsi transfer, the ipsilateral facial nerve stump was used as the recipient nerve in three patients, and a cross-face nerve graft was selected as the recipient nerve in six. The contralateral facial nerve was selected as the recipient nerve in 12 patients, and a thoracodorsal nerve from the latissimus dorsi muscle segment was crossed through the upper lip to the primary recipient branches. A soft-tissue flap was transferred simultaneously with the latissimus muscle segment in three patients. Contraction of grafted muscle was not observed in two patients with gracilis transfer and in three patients with latissimus dorsi transfer. In one patient with gracilis transfer and one patient with latissimus dorsi transfer, acquired muscle contraction was excessive, resulting in unnatural smile animation. The recipient nerves for both of these patients were the ipsilateral facial nerve stumps, which were dissected by opening the facial nerve canal in the mastoid process. From the standpoint of operative technique, the one-stage transfer for latissimus dorsi muscle appears superior. Namely, a combined soft-tissue flap can provide sufficient augmentation for depression of the parotid region following wide resection. A long vascular stalk of thoracodorsal vessels is also useful for anastomosis, with recipient vessels available after extensive ablation and neck dissection. (*Plast. Reconstr. Surg.* 113: 1563, 2004.)

Although many articles have described immediate facial nerve reconstruction following ablative surgery in the parotid region,[1–7] secondary facial nerve reconstruction has received little attention. In primary settings, when a nerve defect that precludes direct nerve suture is evident, nerve grafting and cross-facial nerve grafting are possible options.[8–10] However, cosmetic results achieved with these procedures, particularly with regard to smile function, can be poor because of synkinesis or weak recovery of mimetic muscles, resulting in the need for alternative methods of secondary reconstruction of facial paralysis. Secondary reconstruction is also required in cases where facial paralysis has

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persisted for 1 year or more despite preservation of the continuity of the facial nerve during ablative procedures.

To treat patients with long-standing facial paralysis, we have applied neurovascular muscle transfer to obtain facial reanimation. The intervention differs from those for established facial paralysis resulting from conditions such as congenital dysfunction, Bell palsy, Hunt syndrome, or intracranial seventh nerve damage. This is because ablative surgery of the parotid region frequently results in a soft-tissue defect, which should be restored using a soft-tissue flap combined with the neurovascular free-muscle transfer. Moreover, selection of recipient nerves and vessels can be complicated by previous ablative surgery or intraarterial chemotherapy. The present study describes the operative procedure for neurovascular free-muscle transfer after ablative surgery in the parotid region and demonstrates some representative cases. In our series, either the gracilis or latissimus dorsi muscle was transferred in all cases. Differences between the two operative procedures and the results are also discussed.

Patients and Methods

Patient Profiles

Between November of 1981 and February of 2001, neurovascular free-muscle transfer was performed in 45 patients with facial paralysis following ablative surgery in the parotid region. Patients ranged in age from 5 to 65 years (mean, 34.2 years) at the time of neurovascular free-muscle transfer. Facial paralysis was incomplete in 14 of the 45 patients. Ancillary procedures accompanying neurovascular free-muscle transfer included temporal muscle transfer for eyelid closure in 20 patients, lid loading using a gold plate for the upper eyelid in five, eyebrow lift in 17, and blepharoplasty in six.

Operative Technique

In almost all cases, a preauricular incision was used for primary ablative surgery. This incision was then reused to create a subcutaneous cheek pocket to accept subsequent neurovascular muscle transfer. Recipient vessels were then prepared. The superficial temporal or facial vessels were predominantly used. However, when these vessels were unsuitable for vascular anastomosis because of previous ablative operation, chemotherapy, irradiation, or other such reasons, other vessels in the ipsilateral upper neck were used. If vessels in the ipsilateral neck were unavailable, contralateral vessels were selected as recipients. Vascular grafting was sometimes required in such cases.

Selection of the recipient nerve depends on the condition of the residual ipsilateral facial nerve. When the ipsilateral facial nerve stump was available, it was used as a motor source for innervating transferred muscle.[11] When the ipsilateral facial nerve was unavailable because of the location of the nerve stump deep in the facial nerve canal, contralateral facial nerve branches were used as recipients. In the early cases of our present series, a two-stage method combining neurovascular free-muscle transfer with cross-face nerve grafting[12] was performed. In the first stage of this method, a sural nerve graft between the intact side and paralyzed cheek was used. Approximately 1 year later, the selected muscle (predominantly gracilis, but also latissimus dorsi in some cases) was transferred in the second operation. The motor nerve of the transferred muscle was sutured to the stump of the cross-face nerve graft. After approximately 1995, a one-stage method using latissimus dorsi muscle has been used more commonly.[13] The thoracodorsal nerve of latissimus dorsi was crossed through the upper lip and sutured to a contralateral facial nerve branch in one operation.

When soft-tissue defects required reconstruction because of extensive tumor resection, a soft-tissue flap was simultaneously performed with neurovascular free-muscle transfer. Musculocutaneous flaps using gracilis, latissimus dorsi, or serratus anterior were used for restoration of facial contour in our present series.

Transferred Muscle

Gracilis was used in 24 of the 45 patients, and latissimus dorsi was used in 21.

Selected Recipient Vessels

When gracilis was transferred, recipient vessels comprised superficial temporal vessels in 12 patients and facial vessels in 12. When latissimus dorsi was transferred, recipient vessels comprised facial vessels in 16 patients, the superior thyroid artery and superior thyroid or internal jugular vein in four, and contralateral facial vessels with interpositional graft of the radial vessels in one. In this last patient, ipsilateral vessels were unavailable because of previous ablative operation, radical neck resection,

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and rectus abdominis musculocutaneous flap transfer for coverage of a skin defect following cancer ablation.

Selected Recipient Nerves

When gracilis was used, cross-face nerve grafting was performed before muscle transfer in 22 patients, whereas the ipsilateral facial nerve stump was used as the recipient nerve in the remaining two. When latissimus dorsi was used, recipient nerves comprised the ipsilateral facial nerve stump in three patients and the cross-face nerve graft stump that had been grafted before muscle transfer in six. In 12 patients, the thoracodorsal nerve of the latissimus dorsi muscle, approximately 15 to 16 cm long, was crossed through the upper lip and sutured to contralateral facial nerve branches exposed anterior to the parotid grand.

Soft-Tissue Augmentation

When gracilis was used, a dermal fat flap overlying the muscle was used for cheek augmentation in one patient. Gracilis was used solely for facial reanimation in the other 23 patients, without soft-tissue augmentation in the parotid region. When latissimus dorsi was used, a dermal fat flap overlying the muscle was transferred simultaneously with the muscle segment in one patient. A deepithelialized serratus anterior musculocutaneous flap nourished by a common trunk with the thoracodorsal nutrient vessels of the latissimus dorsi was transferred in two patients for cheek augmentation.

Evaluation

The aims of this operative procedure were reconstruction of a natural or near-natural smile and augmentation of the depressed cheek with soft tissue. The grading scales shown in Table I were used to evaluate smile reconstruction.

Results

In two patients with gracilis transfer and three patients with latissimus dorsi transfer, voluntary contraction of grafted muscle was not observed. In one patient with gracilis transfer and one patient with latissimus dorsi transfer, acquired muscle contraction was excessive, resulting in unnatural animation of the smile. In both cases, recipient nerves were ipsilateral facial nerve stumps that had been dissected by opening the facial nerve canal in the mastoid process.

Smile results for patients with gracilis transfer were evaluated as grade 5 in 10 patients (42 percent), grade 4 in 10 patients (42 percent), grade 3 in two patients (8 percent), and grade 1 in two patients (8 percent). Results for latissimus dorsi transfer were evaluated as grade 5 in nine patients (43 percent), grade 4 in eight patients (38 percent), grade 3 in one patient (5 percent), and grade 1 in three patients (14 percent).

Case Reports

Case 1

A 43-year-old man presented with complete left facial paralysis resulting from ablative surgery of facial nerve schwannoma in the parotid gland 1 year previously (Fig. 1). The one-stage method using latissimus dorsi muscle was planned for smile reanimation. A preauricular incision from the previous operation was reused to create a subcutaneous cheek pocket to accept subsequent latissimus dorsi transfer. Because detailed information from the previous ablative surgery was unavailable, the ipsilateral facial nerve was not used and the contralateral facial nerve branches were selected as recipient nerves. The facial vessels were used as recipient vessels. After transfer of the latissimus dorsi, endoscopic eyebrow lift was performed for eyebrow ptosis, and the upper eyelid was

TABLE I
Evaluation Criteria

Grade	Description
5	Symmetric balance and good facial tone at rest; sufficient muscle power on voluntary contraction; synchronous and natural expression on emotional facial movements, especially on smiling; EMG demonstrating relatively high amplitudes, with full interference patterns and high evoked potential obtained on stimulation of the contralateral facial nerve
4	Symmetric balance and good facial tone at rest; active muscle contraction acquired but not sufficiently synchronous (too strong or slightly weak); EMG demonstrating good interference patterns and evoked potentials; results well accepted by the patient
3	Symmetric balance and good facial tone at rest; insufficient contraction of the muscle; low volitional EMG spikes with discrete interference patterns
2	Reduced symmetric balance on smiling; no effective contraction of the muscle; EMG with no interference patterns
1	No correction; electrically silent EMG
0	No follow-up

EMG, electromyography.

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FIG. 1. A 43-year-old man with complete left facial paralysis caused by ablative surgery of facial nerve schwannoma. Preoperative appearance at rest (*above, left*) and smiling (*above, center*). (*Above, right*) The latissimus dorsi muscle was transferred into a cheek pocket. The contralateral facial nerve branches were selected as recipient nerves and the facial vessels were used as recipient vessels. (*Below*) Five-year postoperative appearance at rest and smiling after surgical revision that was performed 2 years after the neurovascular free-muscle transfer.

loaded with a gold plate for eye closure. Muscle contraction was first recognized 6 months after neurovascular free-muscle transfer. Surgical revision to change the position of muscle attachment was performed 2 years after neurovascular free-muscle transfer. As of 5 years after neurovascular free-muscle transfer, smile result was grade 5.

Case 2

A 49-year-old man presented with complete right facial paralysis resulting from radical parotidectomy and partial mandibulectomy for recurrent mucoepidermoid carcinoma of the parotid gland (Fig. 2). No radiotherapy or chemotherapy had been performed before facial nerve reconstruction. Because the ipsilateral facial nerve was located in the facial nerve canal of the temporal bone, contralateral facial nerve branches were used as recipient nerves. In the first operation, a cross-face nerve graft using a sural nerve segment was grafted through the chin, with concomitant transfer of temporal muscle to the eyelids for eye closure and juxta-brow excision for brow lift. Ten months later, when Tinel's sign had advanced to the end of the grafted nerve, neurovascular free-muscle transfer was performed. Because a depressed deformity of the parotid region was evident following the ablative surgery, a deepithelialized serratus anterior musculocutaneous flap was transferred for soft-tissue augmentation in combination with a latissimus dorsi musculocutaneous flap for facial reanimation. The thoracodorsal vessels nourishing both flaps were anastomosed to the facial vessels and the thoracodorsal nerve was sutured to the cross-face nerve stump. As of 2 years 4 months after neurovascular free-muscle transfer, the patient was satisfied with the results after secondary corrective surgery in which transferred muscle was shortened at the nasolabial fold line. Because the transferred muscle is still weak, the smile result was grade 4.

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FIG. 2. A 49-year-old man with complete right facial paralysis caused by radical parotidectomy and partial mandibulectomy for recurrent mucoepidermoid carcinoma of the parotid gland. (*Above*) Preoperative appearance at rest and smiling. A depressed deformity of the parotid region was evident. (*Center*) A deepithelialized serratus anterior musculocutaneous flap (*S*) was transferred for soft-tissue augmentation in combination with a latissimus dorsi muscle (*L*) for facial reanimation. (*Below*) Two years 4 months postoperatively; appearance at rest and smiling after secondary corrective surgery.

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FIG. 3. A 54-year-old woman with complete right facial paralysis resulting from ablative surgery of squamous cell carcinoma of the right external ear canal. Preoperative appearance at rest and smiling. A severe deformity of the lower face and neck was evident.

Case 3

A 54-year-old woman underwent ablative surgery for squamous cell carcinoma of the right external ear canal (Fig. 3). Resection of the external ear, parotid gland, zygomatic arch, mastoid process, and mandible was performed, along with radical neck dissection. Skin and soft-tissue defects were reconstructed using a rectus abdominis musculocutaneous flap, resulting in complete facial nerve palsy with severe deformity of the lower face and neck. Intraarterial chemotherapy and radiotherapy were performed preoperatively and postoperatively, respectively. One year after ablative surgery, she was referred to us for facial reconstruction. The one-stage method using the latissimus dorsi was planned for facial reanimation. Because vessels suitable for vascular anastomosis were unavailable in the ipsilateral face and neck, contralateral facial vessels were used with an interpositional graft of the radial vessels taken from the left forearm (Fig. 4). Contralateral facial nerve branches were used as recipient nerves. Peripheral Z-plasties to the operative scar of the previous neck dissection and muscle reduction with defatting of the rectus abdominis musculocutaneous flap that had been transferred previously in the ablative surgery were performed simultaneously. Right medial canthal plasty and upper eyelid loading with a gold plate were also performed. As of 1 year 7 months postoperatively, movement of transferred muscle was obtained and the smile result was grade 4 (Fig. 5).

Case 4

A 52-year-old woman presented with complete right facial paralysis following ablative surgery for recurrent pleomorphic adenoma (Fig. 6). Because the ablative surgery had been performed 2 years earlier, neurovascular free-muscle transfer was performed using gracilis for smile reconstruction. The ipsilateral facial nerve stump was initially sought in the scar tissue but could not be found. The mastoid process was then burred to open the facial nerve canal, exposing the proximal stump of the facial nerve for nerve suture. The motor nerve to the gracilis was sutured directly to the facial nerve trunk. Facial vessels were selected as recipients and were anastomosed with the nutrient vessels of the gracilis. The patient presented at our hospital 7 months postoperatively, and excessive contraction of the transferred muscle and bulkiness of cheek skin was evident (grade 4), requiring surgical revision. Transferred muscle was debulked after cheek skin had been undermined to eliminate abnormal facial creases. Furthermore, the nasolabial fold was incised to release the muscular attachment, which was then repositioned using the fascia lata 1 year later. As of 3 years postoperatively, the smile result improved to grade 5.

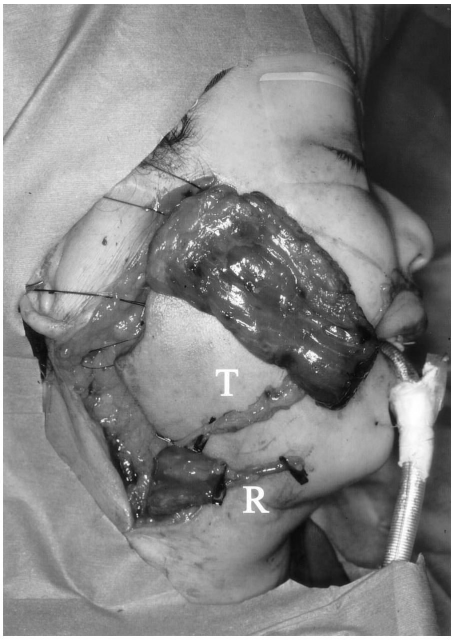

FIG. 4. Because vessels suitable for vascular anastomosis were unavailable in the ipsilateral face and neck, radial vessels (*R*) were interposed between the contralateral facial vessels that were selected as recipients and the thoracodorsal vessels (*T*).

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FIG. 5. Postoperative appearance at 1 year 7 months, at rest and smiling. Contour of the lower face and neck was well restored.

DISCUSSION

Since Harii et al.[14] first reported the use of neuromuscular free gracilis muscle transfer for the treatment of long-standing facial paralysis, numerous reconstructive surgeons have used neurovascular free-muscle transfer as the preferred method for treating long-standing facial paralysis.[13,15–18] In our present series, neurovascular free-muscle transfer was successfully used to treat established facial paralysis following ablative surgery in the parotid region. However, several difficulties exist in this kind of facial reconstruction that are not encountered with reconstruction of established facial paralysis resulting from conditions such as congenital dysfunction, unresolved Bell palsy, Hunt syndrome, or intracranial damage.

Fewer vessels are suitable for microvascular anastomoses, because of radical resection during ablative surgery and/or intraarterial chemotherapy. The superficial temporal or facial vessels that are typically selected as recipient vessels are frequently unavailable. Nutrient vessels for the gracilis muscle are not particularly long and cannot reach suitable vessels in the neck. Gracilis should therefore not be used as a donor muscle when superficial temporal or facial vessels are unavailable. Conversely, nutrient vessels for the latissimus dorsi are long enough to reach vessels in the upper neck area such as the superior thyroid vessels. In reconstructions following radical ablation for parotid tumors, particularly those including neck dissection, use of the latissimus dorsi is preferable to gracilis from the perspective of potential recipient vessels.

Attention must be paid to selecting the recipient nerve. In our series, when the ipsilateral facial nerve branch was available, it was used as a motor source for innervating transferred muscle. Of five patients in whom ipsilateral facial nerves were used, two demonstrated excessive muscle contraction resulting in an unnatural appearance during muscle function. The recipient ipsilateral facial nerve stump for both of these patients was exposed by opening the facial nerve canal in the mastoid process, and the facial nerve main trunk was directly sutured to the motor nerve of the transferred muscle. In the remaining three patients in whom a near-natural smile was achieved without unnatural muscle contraction, the muscle motor nerve was sutured to the stumps of facial nerve branches in the cheek. In a previous report, we reported that unnatural muscle contraction was not seen in 39 patients who underwent muscle graft using the facial nerve on the affected side as a motor source.[11] However, the two patients described here were encountered after that report. Chuang et al.[19] presented four cases in which transferred muscle reinnervated using the ipsilateral facial nerve displayed excessive contraction over time. Because local anesthesia can temporarily relieve muscle tightness, they suggested that excessive reinnervation of the muscle appeared largely responsible for such contracture. However, Harrison noted that fibrous tissue created by

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FIG. 6. A 52-year-old woman with complete right facial paralysis following parotidectomy for a recurrent pleomorphic adenoma. Preoperative appearance at rest (*above, left*) and smiling (*above, center*). (*Above, right*) The harvested latissimus dorsi muscle was divided into two segments, one of which was inserted into a cheek pocket as a neurovascularized muscle for facial reanimation, and the other of which was used with denervation of the thoracodorsal nerve branch for soft-tissue augmentation in the parotid region. (*Below, left*) Postoperative appearance at 7 months while smiling. Excessive contraction of the transferred muscle and bulkiness of cheek skin was evident. Postoperative appearance at 3 years, at rest (*below, center*) and smiling (*below, right*) after revisional operations including debulking.

surgical dissection and the natural biodegradation that occurs before reinnervation may contract with the muscle.[20] Our results seem to support the excessive reinnervation theory of Chuang et al., as two patients in whom the facial nerve trunk was used as the recipient nerve displayed excessive muscle contraction, whereas three patients in whom facial nerve branches were used as recipient nerves demonstrated natural contraction. The facial nerve trunk might be responsible for excessive innervation of the muscle. In three of four patients (excluding a case of Romberg hemifacial atrophy, in which neurovascular muscle transfer may not have been indicated) reported by Chuang et al., the facial nerve trunk was used as the recipient nerve. We therefore presently believe that when a branch of the ipsilateral facial nerve is available in the cheek, it should be used as a recipient nerve, but we do not recommend use of the facial nerve trunk. The contralateral facial nerve branch should be used when the facial nerve trunk is the only ipsilateral option available.

When depression deformity caused by previous tumor ablation in the parotid region is

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conspicuous, soft-tissue augmentation is required. As noted before, gracilis muscles were transferred in the early cases of our present series, when latissimus dorsi muscle transfer was not yet developed. However, dermal fat flaps over the gracilis muscle cannot be adequately set into the defect, as the fat flap over gracilis is difficult to elevate separately from the muscle segment as a composite flap. This is the reason why a dermal fat flap in combination with the gracilis muscle was transferred in only one case for soft-tissue augmentation. On the contrary, many authors have reported that the latissimus dorsi flap can be elevated as a combined flap with other flaps such as the serratus anterior flap and the scapular flap on a single pedicle.[21–24] Kimata et al.[25] reported a case of facial reconstruction using a combination of parascapular flap and latissimus dorsi muscle flap for facial reanimation and soft-tissue augmentation in the parotid region. In our series, a deepithelialized serratus anterior musculocutaneous flap was used for two patients. The thoracodorsal vessels divide into branches to nourish both the latissimus dorsi and serratus anterior muscles. The latissimus dorsi and serratus anterior musculocutaneous flap for soft-tissue augmentation can therefore be harvested as a combined flap for facial reanimation and soft-tissue augmentation, respectively.[26] The serratus anterior musculocutaneous flap may therefore represent the best option for combination with latissimus dorsi transfer, as intraoperative repositioning of the patient is not required, unlike when the scapular flap is used.

CONCLUSIONS

The results of this present series show that the latissimus dorsi muscle represents a better choice than the gracilis muscle for the reconstruction of facial paralysis after ablative parotid surgery, from the perspective of recipient vessels and combined soft-tissue flap, even though no significant difference in acquired smile function of the paralyzed face was evident between the two methods. When the contralateral facial nerve is selected as the recipient nerve, gracilis muscle should typically be used in a two-stage procedure with a cross-face nerve graft, although some authors have reported the use of the gracilis muscle in a one-stage method.[27,28] Conversely, the latissimus dorsi muscle is used in a one-stage procedure, as sufficient thoracodorsal nerve can be harvested to reach the contralateral cheek without nerve grafting. As a result, the latissimus dorsi muscle offers the benefit of a shorter recovery period than the two-stage method using the gracilis muscle.[13] Use of the latissimus dorsi muscle is therefore recommended over the gracilis muscle when the ipsilateral facial nerve branch is unavailable.

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