Results of Management of Facial Palsy with Microvascular Free-Muscle Transfer

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This paper reports our experience in facial reanimation using free innervated muscle transfer in 69 patients with long-term facial palsy. The majority of patients were treated in two stages with cross-facial nerve graft as the first stage and microvascular muscle transfer at the second stage. The gracilis muscle was used in 62 patients. A system of grading results has been utilized in the long-term evaluation. The overall final result was excellent or good in 51 percent of 47 patients who were available for follow-up.

Although the results are not completely satisfactory, they justify the use of this approach to a difficult clinical problem. The results are improving as technical modifications to the procedure have evolved. The gracilis muscle is a reliable free transfer with internal anatomy conducive to use for reanimation of the paralyzed face. This type of transfer, in our experience, has proved superior to nonmicrosurgical methods for treatment of complete and severe incomplete facial palsy. The seventh cranial nerve is used in the innervation of the transferred muscle, the ipsilateral being preferable if available. The authors believe that use of the same cranial nerve is superior to methods that involve other cranial nerves, where spontaneity is often not achieved.

Reconstruction of a patient with paralysis of the facial musculature has always been a challenging problem. Treatment should aim to achieve symmetry at rest, during voluntary motion, and during expression of emotion. Treatment should improve speech and mastication. These aims are best realized by primary or early secondary repair of the facial nerve if this is possible.

The facial nerve mediates the expressions of emotion that are not achieved by conventional methods of reconstruction. Some progress in this regard has been made in the last 15 years by the introduction of cross-facial nerve grafting by Anderl[1] and Smith.[2] Although we have had a small number of good results with this method, the overall results have been inconsistent, especially if it is performed more than 6 months after the original paralysis. This is so because early axonal penetration of the motor end plate is essential to prevent muscle atrophy. Other authors[3,4] have had similar experience with this method. Use of this method for long-standing facial palsies is not advocated.

Harii et al.[6] first reported use of the gracilis muscle for reanimation of the paralyzed face, connecting a branch of the deep temporal nerve to the nerve of the transferred gracilis muscle. Although the resulting movements were exaggerated, a very worthwhile improvement was achieved following secondary reduction of the muscle.

In 1973, we used a two-stage procedure employing a cross-facial nerve graft in the first stage and a free-muscle transfer in the second stage. The extensor digitorum brevis was used initially but was replaced by the gracilis because its results were inconsistent. In subsequent reports from this center[7,8] and by Manktelow,[9] the gracilis muscle has been utilized as a two-stage procedure for long-standing facial palsy where the ipsilateral nerve was not available (Figs. 1 to 3). This report summarizes the long-term results of patients treated in the last 13 years with microvascular free gracilis transfer.

Materials and Methods

From 1973 to January of 1987, 71 free-muscle transfers with microneurovascular technique

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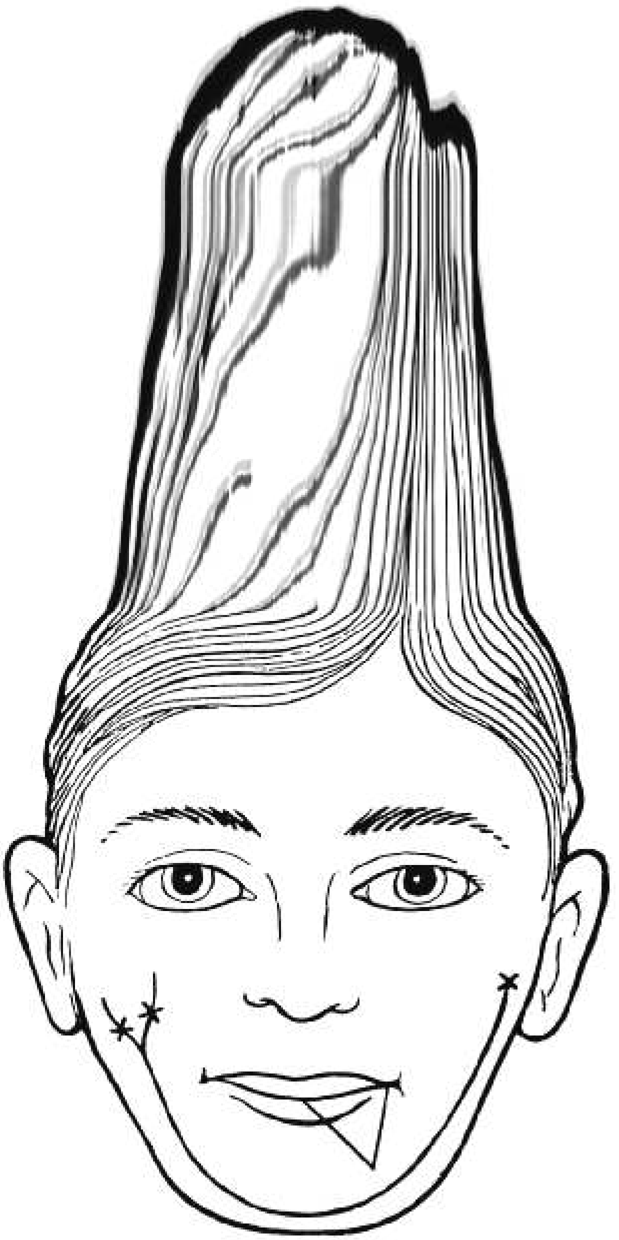


FIG. 1. First stage of the two-stage operation. A single cross-facial nerve graft in the lower face. A wedge resection of the lower lip on the affected side may be done at the same time. A second nerve graft may be placed in the upper face just above the eyebrows if required.

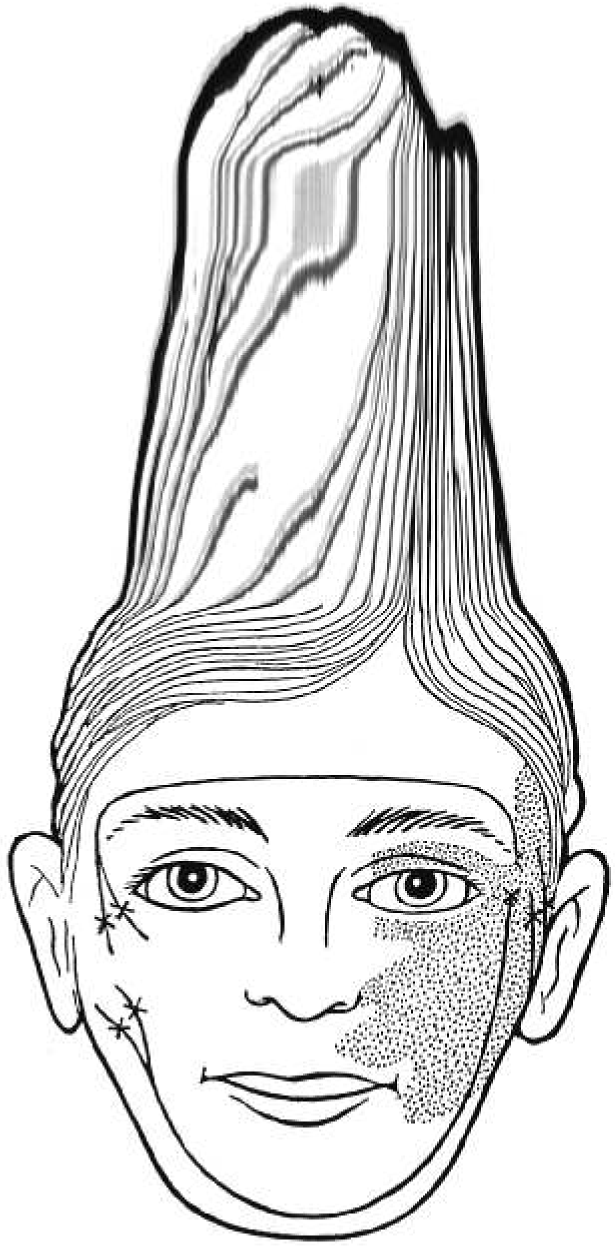
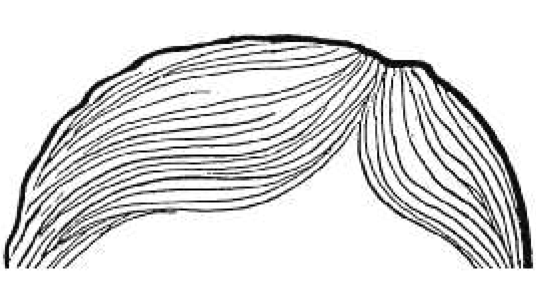


FIG. 3. Second stage of the two-stage operation with muscle inserted to the upper and lower face. Two cross-facial nerve grafts have previously been inserted.



were performed in 69 patients for the treatment of unilateral facial palsy. Each transfer was performed as a single-stage procedure utilizing the ipsilateral facial nerve in 4 patients, and 65 patients had a two-stage procedure using a cross-facial nerve graft in the first stage. Two patients had a repeat muscle transfer after failure of the initial procedure. The muscles used were the gracilis (n = 62), the extensor digitorum brevis (n = 8), and the serratus anterior (n = 1). Of the 62 patients who underwent gracilis transfers, 15 patients were not available for evaluation. The

FIG. 4. (*Left*) A 23-year-old patient with left lower facial palsy following parotidectomy in childhood for a hemangioma. (*Right*) An excellent result 2 years following a one-stage gracilis transfer with union of the gracilis nerve to the ipsilateral facial nerve. A pleasant smile has been achieved.

face lift incision with a submandibular extension. The dissection is carried out with magnifying loupes. The peripheral branches of the facial nerve are identified along the anterior and superior border of the parotid gland. These are marked with 5-0 silk suture loops for later reidentification. Half these branches can be safely divided and joined to the cross-face nerve grafts without weakening the donor half of the face. Simultaneously, one or both sural nerve grafts are harvested. The nerve grafts are reversed in for the eyebrow and eyelid are joined to the upper graft, and those destined for the upper lip and nasolabial fold are joined to the lower graft with 10-0 nylon epineural sutures. The progress of regenerating axons is monitored by a reversed Tinel sign on percussion along the course of the nerve graft. When this has reached the tragus on the paralyzed side, then the muscle transfer is done. This usually takes about 6 to 9 months after cross-facial nerve transfer. In adults, a wedge resection of the lower lip is done at the

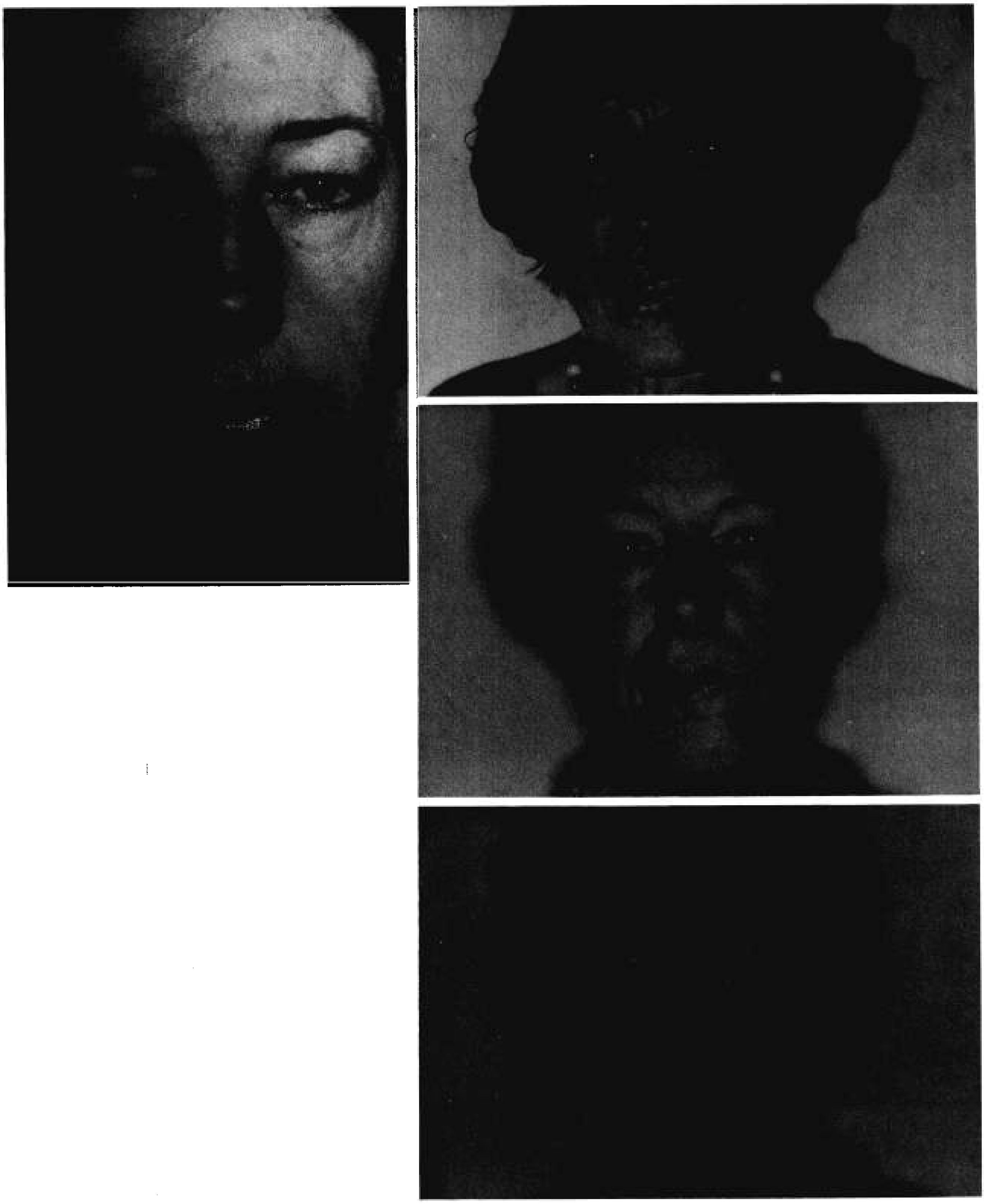


FIG. 5. (*Left*) Patient at rest with a severe incomplete right facial palsy following middle ear infection. (*Above, right*) The same patient smiling with little movement on the right side of the face. (*Center, right*) A good result 6 years after a two-stage gracilis transfer seen at rest. (*Below, right*) The same patient 6 years postoperative seen smiling with good exposure of teeth of upper jaw on elevation of the upper lip. Note the obvious movement of the cheek.

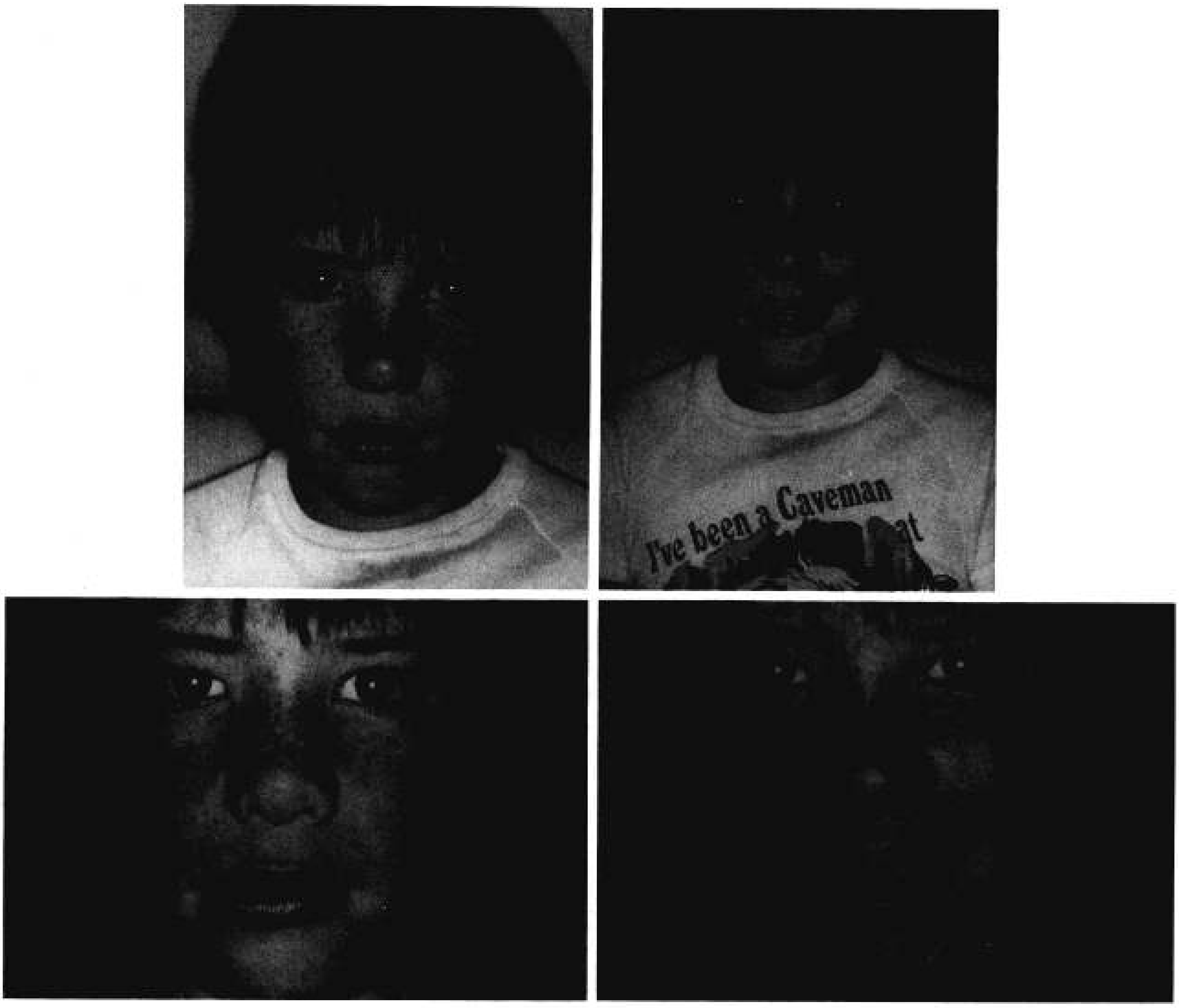


FIG. 6. (*Above, left*) A 5-year-old boy with a congenital right facial palsy seen preoperatively at rest. (*Above, right*) The same patient smiling. Note the lack of elevation of the right upper lip and absence of movement of the right cheek. (*Below, left*) Two years after a gracilis transfer to the right face seen at rest. (*Below, right*) The same patient with a good result 2 years postoperative smiling with improved elevation of the right upper lip and acceptable movement of the right cheek.

branch of the obturator nerve is traced to the obturator foramen. Reduction of the muscle is carried out in situ, securing hemostasis before the vascular pedicle is divided, thereby reducing the risk of facial hematoma following transfer.

The length of the muscle required is measured, and this is marked on the donor muscle. The neurovascular pedicle divides into two or three branches before entering the muscle. One of these vascular branches is ligated, and a nerve branch is divided. The segment of muscle supplied by them is separated by splitting the muscle along its fibers. About half to two-thirds of the muscle with the main vascular pedicle is used as the graft.

If the graft is used to reanimate the whole hemiface, it is necessary to separate the muscle as two motor units. An intrafascicular dissection of the nerve is done at the hilum of the muscle to separate the nerve into two divisions. Using a nerve simulator, the corresponding fibers of the muscle are identified and separated into two units as far as possible. Care should be exercised to protect the blood supply to each segment. One third of the muscle is used for the upper face, and the other two-thirds is used for the lower face.

The paralyzed side of the face is exposed by a modified face lift incision. The skin flap is elevated anteriorly to expose the upper lip and

FIG. 7. (*Above, left*) Young woman with incomplete left facial palsy following parotid surgery seen at rest. (*Above, center*) The same patient smiling preoperatively with diminished movement of the left cheek and impaired elevation of the left upper lip. (*Above, right*) Two years postoperatively after two-stage gracilis transfer to the left cheek. Patient is seen at rest with tethering of the muscle transfer and the left upper lip. (*Below, left*) The same patient after excision of the upper lip scar and release of the muscle from the left upper lip with an excellent smile, good exposure of the teeth, and obviously pleasant movements in the left cheek. (*Below, right*) Close-up photograph of the same patient with elimination of the scar and good elevation of the left upper lip.

angle of the mouth, carefully preserving the cross-face nerve graft. The superficial temporal vessels are then exposed and prepared for anastomosis. The gracilis muscle is transferred to the face with the neurovascular pedicle on the deep surface, enabling subsequent debulking if necessary. For lower face reanimation, the distal end of the gracilis is divided into two segments and sutured with 4-0 Prolene to the muscles of the lateral aspect and angle of the mouth. Intraoperative traction on the orbicularis muscle determines the most appropriate area to attach the gracilis muscle. In the lip, this lateral attachment avoids adherence of the central lip. Insertion into the dermis of the nasolabial line is not recommended because this concentrates the muscle action into this line, creating asymmetry. The proximal muscle is attached to the zygomatic arch extending medially below the orbital margin to give a more vertical lift to the upper lip. The muscle is sutured under tension to overcorrect slightly the deformity.

In complete reanimation, the upper third of the gracilis is divided into two segments that are tunneled into the upper and lower eyelids and sutured to the medial third of the orbicularis oculi muscle. The muscle transfer does not reach the medial canthal area, since this had led to

FIG. 8. (*Above, left*) Young woman with complete right facial palsy seen at rest. (*Above, right*) The same patient with right facial palsy evident on full expression. (*Below, left*) The same patient 3 years after two-stage gracilis transfer to the right cheek seen at rest. Right angle of the mouth is slightly higher than the left, and there is some tethering of muscle evident in the right cheek. (*Below, center*) The same patient 3 years after gracilis transfer smiling with good elevation of the upper lip but some tethering of muscle in the right cheek. (*Below, right*) The same patient 4 years after gracilis transfer and 1 year after release of tethering of muscle of right cheek.

troublesome webbing. The lower two-thirds of the muscle is inserted into the lower cheek as previously described. The proximal end of the muscle is sutured at a higher level to the temporalis fascia.

The vessels are then anastomosed to the superficial temporal vessels with 10-0 nylon sutures, and the nerve graft is joined with epineural sutures to the appropriate segment of the nerve to the gracilis. The wounds are closed with two suction drains placed above and below the muscle graft, lightly sutured into place to avoid close proximity to the vessels.

RESULTS

The etiology of the palsies is illustrated in Table I. Postoperative (41 percent), congenital (29 percent), and traumatic (20 percent) palsies are the most common. Only 10 percent were due to Bell's palsy. The age of the patient at the time of transfer ranged from 6 to 65 years, with the average time being 33 years. The duration of palsy prior to transfer ranged from 1 to 41 years (average 13.6 years). The palsies were left-sided in 18 patients and right-sided in 29 patients. The palsies were complete in 32 patients (68 percent) and incomplete, involving the lower half of the face, in 15 patients. The time interval between the cross-facial nerve graft and the muscle transfer ranged from 4 to 20 months, the average being 8.4 months. In 30 patients the muscle was inserted into the upper and lower face, and in 17 patients it was inserted into the lower face only. A total of 55 surgical procedures had been performed on 34 of these patients prior to muscle transfer (Table II). Two patients had postoperative vascular complications. One had a venous thrombosis, and the other had an arterial occlusion related to atheromatous disease of the temporal artery. Ten patients had hematomas postoperatively, two of them after the first stage. Five of these were drained, and the other five were reexplored to secure hemostasis. Additional drains were inserted to deal with this problem.

The patients' evaluations of the results are illustrated in Table III. The majority (68 percent) felt that their results were excellent or good. Only 9 percent were dissatisfied with their results. More than half considered that they had good symmetry at rest and smiling. There was an improvement in speech in 53 percent and an improved ability to eat in 64 percent. Five (all young women) complained of scarring and contour defects of the donor site, and one patient complained of donor-site pain.

The examination results are illustrated in Table IV. Forty-two patients had some muscle movements resulting in a reasonable facial expression. The expression was good in 28 (60 percent) and fair in 14 (30 percent). Five patients did not have any muscle movement; two of these had vascular complications and two had wound infections. A further 7 patients did not develop movement independent of the other side.

Facial symmetry was good or excellent at rest in 31 patients (66 percent), but only 26 patients maintained good symmetry while smiling. Twenty patients were noted to have evidence of muscle tethering to the skin on smiling. Good elevation of the commissure and the nasolabial fold was achieved in 27 patients (57 percent) and 23 patients (49 percent), respectively.

The ability to close the mouth was good in 32 patients (68 percent). Six patients had oral incon-

TABLE I

Etiology of Unilateral Facial Palsy by Vascularized Muscle Transfer

Congenital	20
Acoustic neuroma	15
Trauma	14
Mastoidectomy	4
Parotidectomy	7
Bell's palsy	7
Meningioma	1
Mandibulectomy	1
TOTAL	69

TABLE II

Previous Surgical Procedures

Tarsorrhaphy	22
Static sling of temporalis transfer	13
Primary nerve graft	6
Hypoglossal nerve transfer	5
Cross-nerve graft	4
Nonvascularized free-muscle transfer	2
Other procedures	3
TOTAL	55

TABLE III

Patient Evaluation of Results

Parameter	Result			
	Excellent	Good	Fair	Poor
Symmetry at rest	6 (13%)	19 (40%)	17 (36%)	5 (11%)
Symmetry smiling	4 (9%)	20 (43%)	15 (32%)	8 (17%)
Satisfaction with result	5 (11%)	27 (57%)	11 (23%)	4 (9%)
	Yes		No	
Speech improved postoperatively	25 (53%)		22 (47%)	
Eating improved postoperatively	30 (64%)		17 (36%)	
Facial pain postoperatively	1 (2%)		46 (98%)	
Donor-site complaints	6 (13%)		41 (87%)	

TABLE IV

Physician Examination Results

Parameter	Result			
	Excellent	Good	Fair	Poor
Symmetry at rest	7 (15%)	24 (51%)	15 (32%)	1 (2%)
Symmetry smiling	4 (9%)	22 (47%)	17 (36%)	4 (9%)
Muscle action	2 (4%)	26 (55%)	14 (30%)	5 (11%)
Muscle bulk	0	28 (60%)	18 (38%)	1 (2%)
Independent action	5 (11%)	17 (36%)	13 (28%)	12 (26%)
Commissure elevation	3 (6%)	24 (51%)	9 (19%)	11 (23%)
Nasolabial fold elevation	3 (6%)	20 (43%)	12 (26%)	12 (26%)
Mouth closure	1 (2%)	31 (66%)	9 (19%)	6 (13%)
Involuntary movement	33 (70%)	3 (6%)	3 (6%)	8 (17%)
Eye closure (muscle in lids)	1 (3%)	11 (37%)	14 (47%)	4 (13%)
Overall final result	1 (2%)	23 (49%)	19 (40%)	4 (9%)

tinence due either to droop of the lower lip or overpull of the transferred muscle.

Thirty patients had muscle transfer to the eyelids in addition to the lower face, 12 of whom had acceptable eye closure. Of the remaining 18 who had problems with complete closure, only 4 required tarsorrhaphy. One patient developed corneal ulceration postoperatively.

The overall result was graded according to the degree of facial scarring, asymmetry at rest and on smiling, muscle bulk, and dyskineses. The results were evaluated to be excellent or good in 24 patients (51 percent) and fair in 19 (40 percent) patients. Comparison of the overall results of the complete versus incomplete, congenital versus acquired, and adult versus child groups, are illustrated in Tables V, VI, and VII. The results were better in the incomplete group. There was no difference in the congenital and acquired groups and with age. Although the results were better when the ipsilateral nerve was used, the numbers are too small to be of statistical significance. The results are illustrated by representative cases (Figs. 4 through 8).

DISCUSSION

The complex function of the facial muscles can be adequately restored only by a primary or secondary repair of the nerve. When this is not

TABLE V
Comparison of Results of Complete versus Incomplete Facial Paralysis

	Excellent	Good	Fair	Poor
Complete	1 (3%)	14 (44%)	14 (44%)	3 (9%)
Incomplete	0	9 (60%)	5 (33%)	1 (7%)

TABLE VI
Comparison of Results of Congenital versus Acquired Groups

	Excellent	Good	Fair	Poor
Congenital	0	6 (55%)	4 (36%)	1 (9%)
Acquired	1 (3%)	16 (33%)	16 (44%)	3 (8%)

TABLE VII
Comparison of Results of Adults versus Children

	Excellent	Good	Fair	Poor
Child	1 (5%)	9 (47%)	8 (42%)	1 (5%)
Adult	0	14 (50%)	11 (39%)	3 (11%)

TABLE VIII
Secondary Procedures

Release of muscle	28
Blepharoplasty	11
Sling to augment muscle	7
Canthopexy/tarsorrhaphy	7
Debulking of muscle	7
Dermal suspension	5
Face lift	5
Temporalis transfer to eyelids	4
Scar revision	4
Nerve surgery	3
Wedge resection lip	3
Reinsertion of muscle	2
Revision of foot scar	1
TOTAL	77

possible, free-muscle transfer in combination with a cross-facial nerve graft is a good substitute. Problems obviously remain as to the proper choice of donor muscle, management of eyelid palsy, and technical details of the placement of the muscle. With experience, the techniques are being constantly refined. The complex nature of long-established facial palsy is such that secondary procedures are often required.

It is difficult to assess objectively or measure the results of reconstruction. However, an attempt to grade the various parameters of facial muscle function has been made, to assess the results as objectively as possible (Table IX). There was good overall patient satisfaction. The results were excellent or good in half the patients, but this is an improvement in comparison with our previous experience with local muscle transfers and slings. The procedure restores independent action and involuntary movements that are not possible by conventional procedures. The results are better in incomplete paralysis involving the lower half of the face.

It would be impossible for any single muscle to be an ideal replacement for all the facial muscles. The gracilis has the advantages of easy access, dispensability, and appropriate vasculature for free transfer. It has a multifascicular nerve which allows one to separate muscle function and thereby allows multiple insertions. Excess bulk of the muscle is overcome by trimming. When trimming is carefully done, preserving the neurovascular anatomy within the muscle, it can still function well with less bulk. It is preferable to debulk the muscle in situ in the thigh and secure hemostasis prior to transferring the muscle, thereby diminishing hematoma formation.

Another problem that has required revision is

TABLE IX

Detailed Analysis of Facial Features at Rest and on Animation (Grading: 1, excellent; 2, good; 3, fair; 4, poor)

I. Symmetry at rest
 1. No detectable asymmetry at rest
 2. Mild asymmetry of oral commissure
 3. Facial asymmetry of commissures but midline in place
 4. Marked asymmetry; midline pulled to other side by normal facial muscles

II. Symmetry on smiling
 1. No obvious asymmetry of mouth with smile
 2. Minimal asymmetry with smiling; commissure of affected side rises to near normal level
 3. Asymmetry of commissure with smile/midline normal
 4. Marked asymmetry; midline shift to normal side

III. Muscle bulk
 1. Affected side with no increase in bulk
 2. Affected side with slight increase in bulk
 3. Affected side with moderate increase in bulk
 4. Affected side with markedly increased bulk; asymmetry

IV. Muscle action
 1. Strong visible muscle contraction
 2. Muscle contraction good; near normal
 3. Minimal visible muscle contraction
 4. No muscle contraction or only palpable facial movement

V. Independent action
 1. Good independent motion of affected side and no detectable movement on normal side with transferred muscle motion
 2. One independent movement of transferred muscle; strong contraction requires some movement of normal side
 3. Partial contraction of muscle required marked contraction of normal side
 4. No muscle contraction visible

VI. Commissure elevation
 1. Normal or nearly normal commissure motion with smiling
 2. Reasonable motion of commissure not level with normal side
 3. Flicker of movement at commissure resulting in asymmetry with smile
 4. No movement of commissure even with muscle contraction

VII. Nasolabial fold elevation
 1. Normal elevation with good facial symmetry
 2. Good elevation of fold; some asymmetry with smiling
 3. Minimal elevation of fold
 4. No elevation of nasolabial fold

VIII. Ability to close mouth
 1. Near normal mouth closure
 2. Close mouth; asymmetry
 3. Mouth closure incomplete
 4. Unable to close mouth; oral incontinence

IX. Ability to close eyes
 1. Normal eyelid closure
 2. Good eyelid closure; may require grimace, resulting in asymmetry
 3. Eyelid closure incomplete; possible corneal exposure
 4. Unable to close eyelids; corneal exposure

X. Involuntary movements
 1. No noticeable or elicited involuntary movement of muscle
 2. Minimal involuntary muscle movement; only with strong contraction of other side
 3. Some involuntary movement of muscle; marked movement of normal side with eye blinking
 4. Marked involuntary movement with dyskinesia or mass movements of face

tethering of the muscle to the skin (Table VIII). More lateral attachment of the muscle in the upper lip has reduced the incidence.

The best results are obtained when the muscle is transferred to the lower half of the paralyzed side. When a single muscle is chosen to replace both the upper and lower face, it is essential to separate the portion of the muscle that meets the upper face from that which meets the lower face by stimulation of individual fascicles. These fascicles should be matched to appropriate ends of the cross-facial nerve graft. The muscle slips inserted into the lids were sometimes too bulky. Medial canthal webbing was avoided by inserting the muscle into the medial third of the eyelid and not to the medial canthus. Despite these attempts, our results of free-muscle transfer for eyelid correction are unsatisfactory. Gold weights are now preferred to muscle transfer for eyelid paralysis.

Vertical lift of the upper lip is a difficult feature to achieve. By adapting the modification suggested by Manktelow[9] and attaching a segment of gracilis more medially, a better upward lift of the upper lip is obtained. Similarly, it is important to obtain a good attachment to the atrophic muscle of the upper lip to avoid shift of the midline to the normal side. Otherwise, an abnormally long midline-to-commissure length of the affected side would result. Correction of depressor function of the lower lip remains a problem. Attempts at reconstruction of this deformity with diagastric muscle transfer and other nonstatic procedures have not proven satisfactory. Wedge excision of a portion of the paralyzed lower lip has given the best result in selected adults. This deformity of the lower lip in children is much less obvious.

The results indicate that free-muscle transfer is a useful procedure in restoring symmetry and independent movement to the paralyzed face. It is indicated when nerve repair or cross-nerve grafts are not possible or have failed. The gracilis muscle is a good donor muscle because of its easy access and low donor morbidity. Because of its long parallel fibers, it can be split into more than one muscle function. Some of its disadvantages, such as bulk, have been overcome by technical refinements in the procedure.

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