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Reanimation for facial palsy using gracilis muscle grafts

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SUMMARY. **Twelve patients have been reviewed at least 2 years after gracilis muscle transfer, preceded by cross-face nerve grafting, for complete unilateral facial palsy. Levels of satisfaction among the patients were good. Examination showed all had voluntary movement of the graft which could produce reasonable mouth symmetry in most patients. However, the involuntary spontaneity and expressive movements were not so satisfactory, though still worthwhile. The technique and some lessons learned from this experience are discussed. It appears from electromyographic studies that continuing innervation and activity can occur in these grafts for many years postoperatively.**

One method for the management of lower motor neurone facial paralysis is cross-face nerve grafting followed by the transfer with microvascular and microneural anastomoses of a muscle from elsewhere in the body (Harii *et al.*, 1976; Terzis *et al.*, 1978; O'Brien *et al.*, 1980; Tolhurst, 1980; Harrison, 1985). The purpose of these procedures has usually been to obtain more spontaneous and symmetrical movements on the affected side, smiling in particular.

We have long-term follow-up on a group of 12 patients who have had such a series of operations using gracilis muscle in an attempt to reanimate the angle of the mouth on the affected side, and this report documents the procedures used, the results and the problems encountered.

Patients and methods

Twelve consecutive patients who have been operated on as above and could be contacted, with a minimum period of 2 years since the muscle transfer, were available for study. All patients were below the age of 60, ranging from 6 to 59 years, at the time of muscle transfer. All had complete unilateral palsies prior to treatment. The aetiology of the palsies and the patient details are shown in Table 1. All had a two-stage programme comprising a single reversed cross-face sural nerve graft initially, followed by gracilis muscle transfer at the second stage when there was evidence on clinical examination of axonal growth across the face to the end of the nerve graft. The period between stages varied from 4 to 14 months.

Table 1 Patient details

Patient	*Aetiology*	*Yrs since op.*	*Age at op.*
1	Cholesteatoma	5.5	47
2	Acoustic neuroma	5	34
3	Acoustic neuroma	6	37
4	Acoustic neuroma	6	41
5	Bell's palsy	9.5	6
6	Trauma	9.5	22
7	Infection	7.5	18
8	Acoustic neuroma	5.5	59
9	Congenital	3.5	15
10	Congenital	3	24
11	Bell's palsy	2.5	37
12	Acoustic neuroma	2	35

Operative technique

At the first stage a single sural nerve graft is harvested from one leg with the patient supine but tilted laterally so the back of the leg is accessible. The distance across the face from the anterior border of the parotid on the innervated side, through the upper lip to the preauricular area on the paralysed side is measured and at least this length of sural nerve obtained. Four or five small stepladder incisions up the back of the leg are used for harvesting the nerve. Careful scissor dissection along the nerve rather than any kind of stripper is used.

In the face a preauricular parotidectomy type incision on the innervated side is made and after dissection forward to the anterior border of the parotid, appropriate branches of the facial nerve identified. This is aided by an anaesthetic technique previously described (Ward and Poole, 1983) in which neuromuscular blockade is avoided so a nerve stimulator can be used to find one or two branches which, when stimulated, produce elevation and lateral movement of the angle of the mouth and upper lip without spread into the upper cheek or eyelid muscles. In practice these branches are usually closely related to the parotid duct. On occasions splitting of the branches is employed (Gary-Bobo *et al.*, 1980), and at other times the whole of the branch is cut and used for anastomosis.

The sural graft is passed through the face by stitching its proximal end onto one of the curved stabbers used to pass size 10 suction drains. The first pass of the stabber is from the site of the nerve branch(es) identified for anastomosis, into the upper lip and out through the nostril floor of the paralysed side. A further pass from here high under the alar base and high up across the malar area of the paralysed cheek is then made to come out just anterior to the tragus. The graft is thus reversed so side branching will not divert axons growing through it away from the terminal end. Anastomosis of the graft to the chosen branches under the microscope is then carried out and after checking there is no tension on the anastomosis, the far end of the graft is trimmed and marked with a silk stitch for easy identification at stage two, and the wounds are closed (Fig. 1).

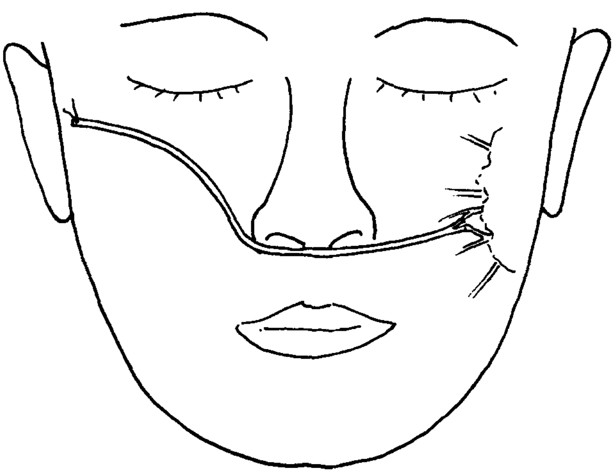

Fig. 1

Figure 1—Diagram of the stage one procedure, with the reversed sural nerve graft passed across the face.

In our series only one graft has been used, and no attempts have been made to reanimate the eyelids with nerve grafts or muscle.

At postoperative follow-up, tapping along the nerve graft evokes a Tinel's sign, and when this has advanced to the end of the graft in the paralysed side preauricular region, the second stage is arranged.

The second stage is done through a parotidectomy incision on the paralysed side, and also an incision 3 cm long around the oral commissure in the mucocutaneous junction. After identification and dissection of the nerve graft to the malar area, a wide tunnel is dissected obliquely from the temporal region to the angle of the mouth to join the incisions. The lower part of this tunnel medial to the desired nasolabial fold is at a subdermal depth, but laterally is deeper. Care needs to be taken of the parotid gland (a more recent patient has had a troublesome parotid fistula postoperatively due to the plane of dissection being too deep). Two tunnels are also dissected in the upper and lower lips from the commissural incision to small incisions in the buccal aspects of the lips on the normally innervated side of the midline. The superficial temporal vessels are identified and prepared for anastomosis.

The upper third of the ipsilateral gracilis muscle is harvested through an incision over it with the main vascular pedicle in the upper third of the thigh, and a few centimetres of the motor nerve to gracilis which is easily identified. After removal of the muscle graft it is taken to a side table and at least the antihilar half of it, and the posterior part, thinned away. More recently we have thinned the muscle more aggressively.

Intramuscular motor nerve branches encountered during thinning are reimplanted into the muscle of the graft portion. The muscle is then passed through the facial tunnel and positioned so that the vascular pedicle lies superficially and comfortably adjacent to the superficial temporal vessels, and the upper end of the graft trimmed and sutured to the temporalis fascia. The lower end of the graft is separated into three main slips—two deep ones to go through the lip tunnels to the normal muscle contralaterally where they are sutured, and a more superficial and shorter lamina which is sutured to the modiolus and more laterally to the dermis along the line of the desired nasolabial groove. The tension in the graft is adjusted so that there is just slight over-correction of the affected corner of the mouth. The dermis between the commissural incision and the nasolabial groove is sutured down to the muscle lamina and after suitable skin excision the commissural and lip incisions closed.

Microvascular anastomosis of the vessels is then done. At this stage, if the patient is not under the influence of neuromuscular blockade a nerve stimulator can be used on the graft to produce twitches and see the effect on the lip and nasolabial region of contraction and minor adjustments there can still be carried out if required. Finally the nerve graft is trimmed and anastomosed to as short a pedicle of gracilis nerve as possible, without tension, and the facial wound closed (Fig. 2).

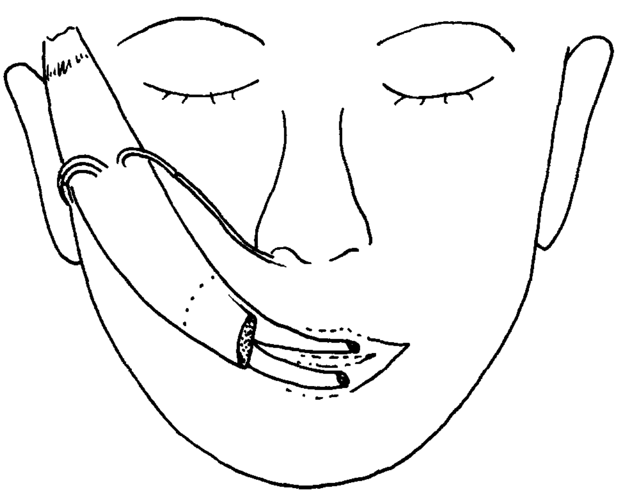

Fig. 2

Figure 2—Diagram of stage two, with the gracilis transfer in situ in the face.

Postoperative monitoring in our series has been simply by listening with a Doppler for flow in the gracilis vascular pedicle just under the cheek skin.

Follow-up study

This follow-up study has been in three parts—a postal questionnaire which each patient filled in, followed by interview; still photographs and video of each patient; and in four patients electromyographic studies of the muscle graft were also done. Electromyograms were recorded by inserting a concentric needle electrode into the gracilis graft near its mid-point. The electrode was adjusted in depth and direction during voluntary movement of the face to produce the cleanest and largest motor unit potentials and these were displayed and recorded on photographic paper. The sural graft was stimulated percutaneously with brief 0.2 msec square waves at a frequency of 1 hz and an intensity sufficient to fire all the motor fibres (usually greater than 100 volts). The sites of stimulation were (1) over the donor facial nerve at the level of the parotid gland, (2) on the donor nerve side and (3) at the lateral side of the upper lip on the muscle graft side. Velocities were calculated in the usual way utilising the measured latencies of the responses on the film and the estimated conduction distance (in mm) between the points of stimulation. The four patients who had these investigations had previously had similar studies 4 years ago and have been reported (Rayment *et al.*, 1987), and were repeated to look for late or continuing changes.

Results

Questionnaires and interview

Table 2 shows the distribution of answers to some of the key questions asked. The majority of patients report high levels of satisfaction postoperatively and feel the procedures have been worthwhile and pro-

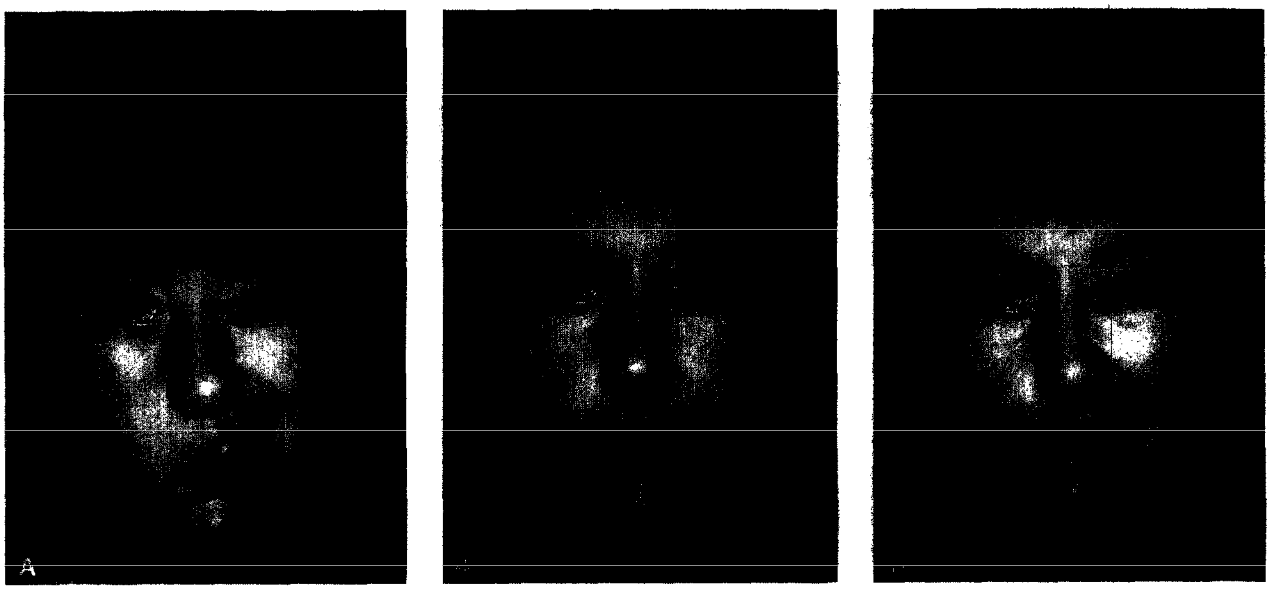

Fig. 3

Fig. 4

Figure 3—(A) A patient preoperatively. (B) Postoperatively at rest. (C) Postoperatively attempting to smile. This patient had the muscle thinned prior to this, resulting in weakness of the gracilis graft. She also has to screw up her eye to make the transfer work. **Figure 4**—(A) A patient preoperatively. (B) Postoperatively at rest. (C) Postoperatively smiling. This patient has a Morel-Fatio spring in the upper eyelid.

Table 2 Questionnaire results

Preoperative concern	—very concerned	10
	—fairly concerned	1
	—concerned	1
Postoperative satisfaction	—very satisfied	6
	—fairly satisfied	5
	—fairly unsatisfied	1
Degree of improvement	—greatly improved	11
	—slightly improved	1
Procedures worthwhile?	—very worthwhile	9
	—quite worthwhile	3
Recommend to others?	—yes	12
How far from normal now?	—far	1 (eye)
	—nearly normal	10
	—normal	1

Table 3 Factors currently of concern to patients

Operated side of face more swollen	3
Lopsided smile	3
Discomfort in face	3
Eye problems	2
Would like better results	1
Have to snarl to get movement	1
Pain in donor leg	1
Muscle weakened by thinning	1
Frey's syndrome	1
No problems reported	3

duced great improvement in their appearance. The one patient who is fairly unsatisfied would nevertheless recommend the procedure to similar sufferers (this patient suffered considerable weakening of the activity of her graft after a thinning procedure, and her graft is also inappropriately innervated such that she has to screw up her eyes to get it to work). Some aspects of their appearance or function continue to bother patients and these are listed in Table 3. The patient who noted the least improvement was the oldest, and

Fig. 5

Fig. 6

Figure 5—(A) Another patient preoperatively. (B) Postoperatively at rest. Some puckering is seen on the cheek over the muscle. (C) Postoperatively smiling. **Figure 6**—(A) Another patient preoperatively. (B) Postoperatively at rest. (C) Postoperatively smiling. Note the smoothness on the upper nasolabial area on the grafted side.

has had considerable problems with his eye, for which he refuses surgery. Interestingly six patients feel that their face is still changing, two of these having had their operation nearly 10 years ago.

Photographs and video

Some results are shown in the Figures 3–6. While all grafts have active function, on video and in conversation with the patients it is noted that in many of them there is a latency of activity in the graft such that rapid response during conversation is often absent or somewhat inappropriate, as has been reported previously (Rayment *et al.*, 1987). Another feature, more obvious on video than still photographs, is a smoothness in the upper nasolabial region compared with the normal side.

Electrophysiology

The gracilis grafts of all four patients showed more motor unit activity than 4 years ago when they were last examined (now 5–7 years since gracilis grafts inserted) and the velocity of motor nerve fibres within the sural grafts had increased in all of them (Table 4, Fig. 7). The photographic records of the motor unit potentials show an increase in the number of motor units rather than a marked increase in duration or polyphasicity, and this shows that there are more motor nerve fibres innervating the grafts by continuing motor nerve fibre regeneration, rather than terminal sprouting of axons which had already reached the muscle grafts 4 years ago. The demonstrated increase in the velocity of regenerating motor nerve fibres shows that the regenerating fibres have reached maturity.

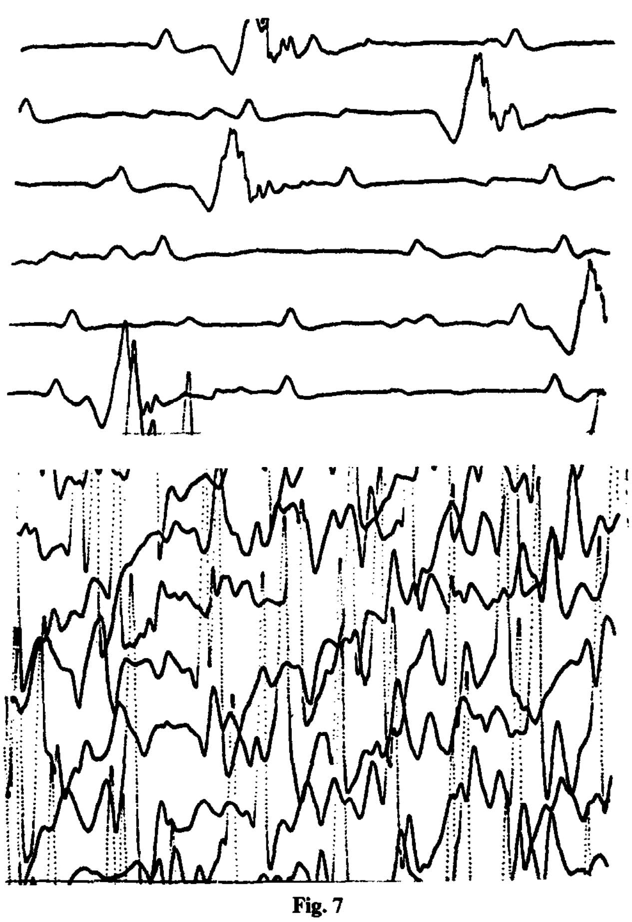

Fig. 7

Figure 7—(A) Concentric needle electrode recording from the gracilis graft during activity in the patient in Figure 6 in 1985, 2 years after the gracilis transfer. (B) Recording from the same patient in 1990, 7 years after the gracilis transfer.

Table 4 Electrophysiological results

Patient	*1*	*2*	*3*	*4*
Interval from palsy to muscle graft	2.25 yr	9 mnth	2.5 yr	8 mnth
Interval from muscle graft to 1st exam.	11 mnth	10 mnth	2 yr	2.5 yr
Conduction velocity 1st exam. of grafted nerve	21 m/sec	13 m/sec	26 m/sec	37 m/sec
Interval from 1st exam. to 2nd exam.	4.5 yr	4.25 yr	4.5 yr	4.75 yr
Conduction velocity 2nd exam. of grafted nerve	28 m/sec	24 m/sec	32 m/sec	42 m/sec

No evidence was found of any regeneration of motor nerve fibres to the adjacent paralysed facial muscles.

There has been no evidence of weakness on the normal side of the face from the use of nerve branches there. Two patients had early postoperative haematomas which required evacuation. None of the vascular anastomoses needed re-exploration. Subsequent procedures to debulk the muscle graft have been necessary in four patients (causing weakness of the graft in one), and five have had minor adjustments of the muscle insertion.

Discussion

Despite the qualifications about symmetry and function, and the degree of secondary surgery which has been needed, we believe that the results are superior to reanimation using trigeminally innervated muscle such as temporalis in our hands, and the function achieved, albeit not perfect, makes the operations worthwhile to us as surgeons. That the results satisfy the patients is strongly borne out in general by the questionnaire results.

The choice of gracilis muscle has only been a problem in this series in terms of its bulk. It has been suggested that gracilis is too strong and overacts but we did not find that a problem. The bulk shows as a prominent cheek and thinning has been done for that reason rather than because of overactivity. We now carry out much more radical thinning at the time of muscle grafting and this should obviate later thinning procedures, which as mentioned above are not without hazard. The length of the gracilis vascular pedicle and the ease of harvesting the graft have made it our muscle of choice rather than pectoralis minor.

Siting the nerve graft through the upper lip means the graft can be short but on the other hand makes one cautious about dissection near the alar base at the second stage for fear of damaging the nerve. We have avoided using a nasolabial incision to expose this area (Harrison, 1985) to save making another scar. The flattening of the upper nasolabial area in our patients, shown in Figures 3–6, is no doubt due to inadequate muscle graft insertion here and we do now dissect carefully high into the upper lip via the commissural incision to try and get more muscle attachment there, and hope for better results in the future. An alternative is to place the nerve graft across the face under the lower lip (O'Brien *et al.*, 1980), which requires a much longer graft, and we have not tried this.

The method of insetting the lower end of the graft into the lips and adjacent areas has been satisfactory, particularly in later cases when our experience had improved. To expect one muscle vector to produce symmetry with the opposite normal side with its numerous muscle insertions is of course naive, and it is surprising really that function is as good as it is, probably because smiling is the major activity of the area treated, and perhaps is the easiest to imitate with a single vector.

The improvement in the numbers of innervated motor units in the grafts over a period many years after surgery is interesting. Terzis has stated that in rabbits there was no further improvement after 1 year (Terzis *et al.*, 1978). The continuing changes in EMGs in our patients may correlate with the observation of half the patients that their facial function is still changing. The absence of any neurotisation of adjacent facial musculature, expected by O'Brien *et al.*, is probably due in our cases to the fact that the palsies were of at least 2 years' standing and the denervated facial muscles would have degenerated irreversibly by the time any axons from the nerve/muscle graft reached there.

Some surgeons have become disillusioned with vascularised muscle grafting for facial palsy (Tolhurst, personal communication). While it takes 18 months at least to see much benefit from the procedures we have described, we believe our results justify the method, particularly in young, well-motivated and fully informed individuals. We hope to see these results improving further in the future with the modifications in technique mentioned above.

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