British Journal of Plastic Surgery (1995), **48**, 83–88

BRITISH JOURNAL OF PLASTIC SURGERY

Cross-face reanimation of the paralysed face, with a single stage microneurovascular gracilis transfer without nerve graft: a preliminary report

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SUMMARY. **This paper describes a method of cross-face reanimation of the paralysed face by a single stage transfer of gracilis. In this method, the nerve to the gracilis is kept long and tunnelled across the upper lip and joined directly to branches of the facial nerve on the normal side. The method avoids the need for a nerve graft and shortens the period of rehabilitation by 12 months. The results in 3 cases were good in 2 cases and fair in 1 case.**

The facial nerve controls involuntary facial movements and emotional expression. In the paralysed face these functions are satisfactorily restored only with primary or secondary nerve repair. When nerve repair is not possible because the proximal stump of the facial nerve is not available, emotional expression can be partially restored by using the contralateral facial nerve to reanimate the paralysed muscles. Smith described the technique of cross-face nerve grafting in which a graft was used to connect selected branches of a normally functioning contralateral facial nerve to the trunk of the paralysed nerve.[1] Favourable results using cross-face nerve grafts were reported by Anderl[2] and Ferreira.[3] Most authors, however, report that the results with this technique are inconsistent, especially in palsies of more than 6 months,[4–7] presumably because of muscle atrophy.

In long-established facial palsies, the paralysed facial muscles undergo degeneration and cannot be expected to recover. In these cases, other methods of muscle transplantation are required. Harii *et al.* reported 2 cases of free microvascular transfer of the gracilis in the treatment of facial palsy.[8] They joined vessels of the gracilis to the superficial temporal vessels and the nerve to the ipsilateral deep temporal nerve. Although voluntary movements of the transferred muscles were achieved, there were exaggerated involuntary movements on chewing. Because of innervation by a different cranial nerve, synchronised emotional expression was also not possible. The first free muscle transplant performed by O'Brien *et al.* was an extensor digitorum brevis transfer, with the descendens hypoglossi nerve in the neck as the donor nerve.[4] O'Brien *et al.* later combined a cross-face nerve graft with free muscle transfer, which offers the best prospect for restoring muscle tone and voluntary and emotional expression in long established facial palsy.[4,9] In this method, a cross-face nerve graft is inserted in the first stage followed by free microvascular transfer of muscle in the second stage. The second stage is performed on average 6–12 months after the first stage[10,11] and therefore the results of reconstruction are not apparent to the patient for nearly 18–24 months. Good results have been reported using this method by O'Brien *et al.*,[4,11] Harii,[10] Sassoon *et al.*,[12] Harrison[13] and others, and is now the mainstay in the management of facial palsy. The main drawback of this 2-stage technique is the delay. O'Brien and Kumar in 1991 therefore investigated the use of a single stage technique for cross-face reanimation of the paralysed face.[14] In this technique the nerve to the gracilis is kept long. It is tunnelled across the upper lip and anastomosed to branches of the contralateral normal facial nerve just lateral to the nasolabial fold. The method avoids the need for a nerve graft and facial reanimation occurs within 6 months. O'Brien *et al.* had previously unsuccessfully attempted single stage cross face reanimation in one case, using the extensor digitorium brevis and the anterior tibial nerve joined to the opposite facial nerve just lateral to the nasolabial line.[4] In a later review of 69 patients, O'Brien *et al.* reported that 4 had had free muscle transfers, with a microneurovascular technique, as a single-stage procedure utilising the ipsilateral facial nerve.[11] They merely noted that the results were better when the ipsilateral nerve rather than a cross-facial nerve graft was used, but the numbers were too small to be of statistical significance. This paper presents the first successful cross-face reanimation of the paralysed face using a gracilis muscle transfer in a single stage. The preliminary results with the technique carried out on 3 patients in the last 4 years are presented.

Operative technique

Preparation of donor muscle

The gracilis muscle is an ideal muscle for single stage transfer. It has a single, reliable vascular pedicle with a long nerve (10–12 cm) and can be easily harvested without functional loss. In addition, it has a fairly consistent neurovascular anatomy which permits

harvesting the anterior third of the muscle as a separate motor unit, thereby avoiding excessive bulk.

The contralateral gracilis is exposed through an incision made in the proximal half of the line joining the adductor tubercle to the medial condyle of the femur. This line corresponds to the posterior margin of the adductor longus muscle which is tensed by abduction and external rotation of the thigh. The anterior border of the gracilis muscle is postero-medial to the adductor longus. This border is mobilised to identify the vascular pedicle of the gracilis which is at the junction of the upper quarter and lower three quarters of the muscle. The vascular pedicle is mobilised to its origin from the profunda vessels, with division of all branches from it to the overlying adductor longus muscle. The nerve to the gracilis, which arises from the anterior division of the obturator nerve, is traced to the obturator foramen. The other branches from this division to the adductors longus and brevis are preserved by intraneural dissection. 10–12 cm of nerve can be harvested with the muscle flap. Tiny blood vessels that run in the fascia on the outer surface of the nerve should be preserved to maintain the blood supply to the distal half of the nerve.

Thinning of the muscle is carried out in situ to reduce ischaemia time. It also allows haemostasis before the vascular pedicle is divided and avoids haematoma. An incision is made along the muscle fascia on the posterior border of the muscle. The fascia is elevated from the medial and lateral surfaces of the muscle. The muscle is split longitudinally, taking about a half to a third of the muscle with the main vascular pedicle. The muscle is thinned, if required, by carefully excising the muscle fibres on the medial surface. The muscle fascia is now wrapped around the graft and sutured with fine absorbable sutures. This prevents tethering of the muscle to the skin. The required length of the muscle, usually not more than 6–8 cm, is marked and the muscle divided. The proximal end of the gracilis is divided close to the vascular pedicle so that most of the muscle graft is distal to the vascular pedicle. To permit the nerve to reach the contralateral side, the muscle graft is reversed in the face. The remainder of the gracilis muscle is left in the thigh; its blood supply is maintained by the other arteries to the muscle.

Preparation of recipient site

A parotidectomy incision with a submandibular extension is used to expose the paralysed side of the face. A skin flap is elevated anteriorly to expose the alar base, upper lip and the angle of the mouth.

An incision is now made on the contralateral normal side of the face, 1 cm lateral and parallel to the nasolabial fold. Peripheral branches of the facial nerve are identified anterior to the parotid gland and marked by silk loops. One or 2 of these branches are later divided and joined to the nerve to the gracilis.

The muscle is transferred to the face with its neurovascular pedicle on the deep surface, as this permits subsequent thinning of the muscle if required. The proximal end of the gracilis is sutured to the alar base, upper lip and the modiolus using non-absorbable sutures. The neurovascular pedicle is now in an inferior position (Fig. 1). The distal end of the muscle is stretched to its original length and sutured to the inferior orbital margin and zygoma. This vertical placement of the muscle is preferred as it replaces the zygomaticus major, the dominant smile muscle. The nerve is tunnelled across the upper lip and joined to one or two branches of the facial nerve. The vascular pedicle is in a suitable position for anastomoses with the facial vessels.

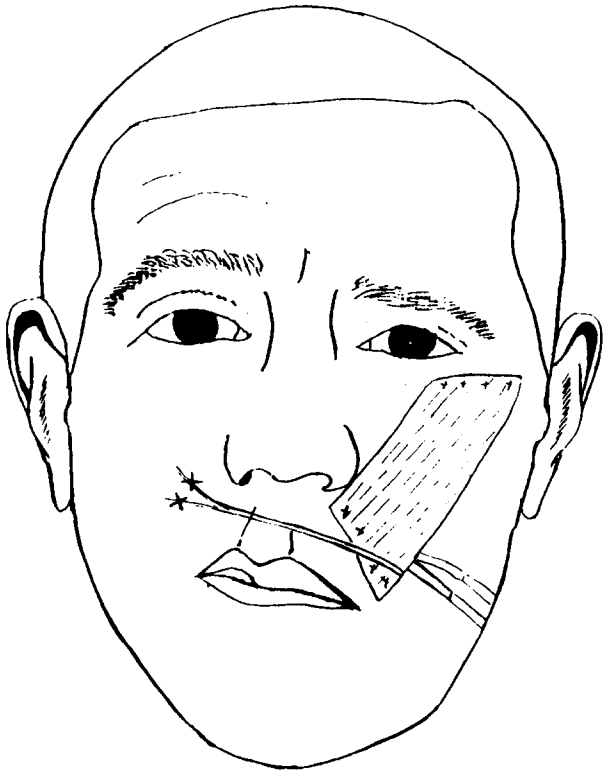

Fig. 1

Figure 1—Diagram illustrating single-stage transfer. The muscle is reversed so that the neurovascular hilum is inferior.

Case reports

Case 1

A 23-year-old women had Bell's palsy with complete paralysis of the left side of her face. No recovery of the paralysis had occurred in the following 1 year. At presentation in September 1989, her main complaint was asymmetry of the face and inability to close the eye. A single stage gracilis transfer using the technique described was done in September 1989. In October 1990, she had good movements of the transferred muscle, with good elevation but some asymmetry of the upper lip during smiling (Fig. 2A, B). A temporalis transfer was done to enable closure of the left eye.

Case 2

An 11-year-old boy had complete lower motor neurone paralysis of the right facial nerve following severe head injuries with fracture of the base of the skull. He had a craniotomy and was unconscious for many weeks. At presentation in May 1990, he had marked asymmetry of the

Fig. 2

Figure 2—*Case 1.* Postoperative views at rest (A) and smiling (B). Illustrates good elevation of the upper lip during smiling but some asymmetry persists. Note tethered scar on right cheek.

face (Fig. 3A, B), constant drooling and slurred speech. A single stage gracilis transfer was done in June 1990. He had a postoperative wound infection with abscess formation, which required antibiotics and aspiration. Despite this complication, movement of the gracilis was noted in January 1992: this was confirmed by EMG. He now has improved tone and symmetry of the face and does not drool (Fig. 3C, D). The elevation of his lip is weak and the two sides of the face do not move independently. The scar on the left cheek was hypertrophic. Although this settled down, the scar was stretched. His result was assessed as fair.

Case 3

A 56-year-old man presented in October 1992 with a complete left facial paralysis following surgery for acoustic neuroma in July of the same year. He had severe facial asymmetry, eyebrow ptosis, inability to close his left eyelids, and difficulty in eating and drinking (Fig. 4A–C). A single stage gracilis transfer was carried out in November 1992. Movement of the transferred muscle was first noticed in May 1993, 6 months following the transfer: this was confirmed by EMG studies. One year following transfer, he had good symmetry on rest (Fig. 4D), and animation (Fig. 4E, F). Some asymmetry persisted on smiling. He had independent movement on both the sides. He no longer has difficulty in eating and drinking. In February 1994, his left eyebrow ptosis was corrected and lid closure was improved by a temporalis transfer.

Discussion

Single stage reconstruction with free muscle transfer has been reported when the proximal stump of the ipsilateral facial nerve is available. However this technique was possible in less than 5% of patients in the series reported by O'Brien *et al.*[11] and Harii;[10] most of their patients required 2-staged reconstruction. In both series, there were better results with the single stage method when the ipsilateral facial nerve was used to reinnervate the transferred muscle, compared with the 2-stage method using a cross face nerve graft from the contralateral facial nerve. This is probably because the number and size of the regenerated myelinated fibres at the distal end of a cross face nerve graft are decreased.[10,13] Harii therefore recommended delaying the second stage of free muscle transfer for about 12 months after the first stage to permit increased myelination of the regenerating axons.[10] The result of reconstruction would therefore not be apparent to the patient for nearly 2 years after the onset of reconstruction. The single stage gracilis transfer avoids the first-stage nerve graft of the 2-stage method of reconstruction. Reinnervation of the muscle was observed in all 3 cases within 6 months. Even in Case 2, who had a wound infection, reinnervation of the muscle was demonstrated by EMG studies at 6 months. However, the result in this case was the least satisfactory. The factors which probably contribute to early and more complete reinnervation of the muscle are that the regenerating axons have to contend with the scar barrier of only one suture line and have a shorter distance to traverse. The nerve to the muscle retains its blood supply for most of its length and in effect is a vascularised graft. Taylor has produced experimental and clinical evidence of more rapid axonal regeneration and remyelination with the use of vascularised nerve grafts.[15,16] Retaining the blood supply to the nerve in a single stage transfer probably results in early reinnervation of the muscle but whether it makes a significant difference to the result is uncertain. By comparing the results of the single stage with the 2-stage technique, where the only criterion for selection of the operative procedure is patient choice, may provide this answer in the future.

Harii *et al.* reported single stage transfer of the gracilis in which the deep branch of the temporal nerve was used as the donor motor nerve. Harii now prefers the hypoglossal nerve as the motor and recommends it

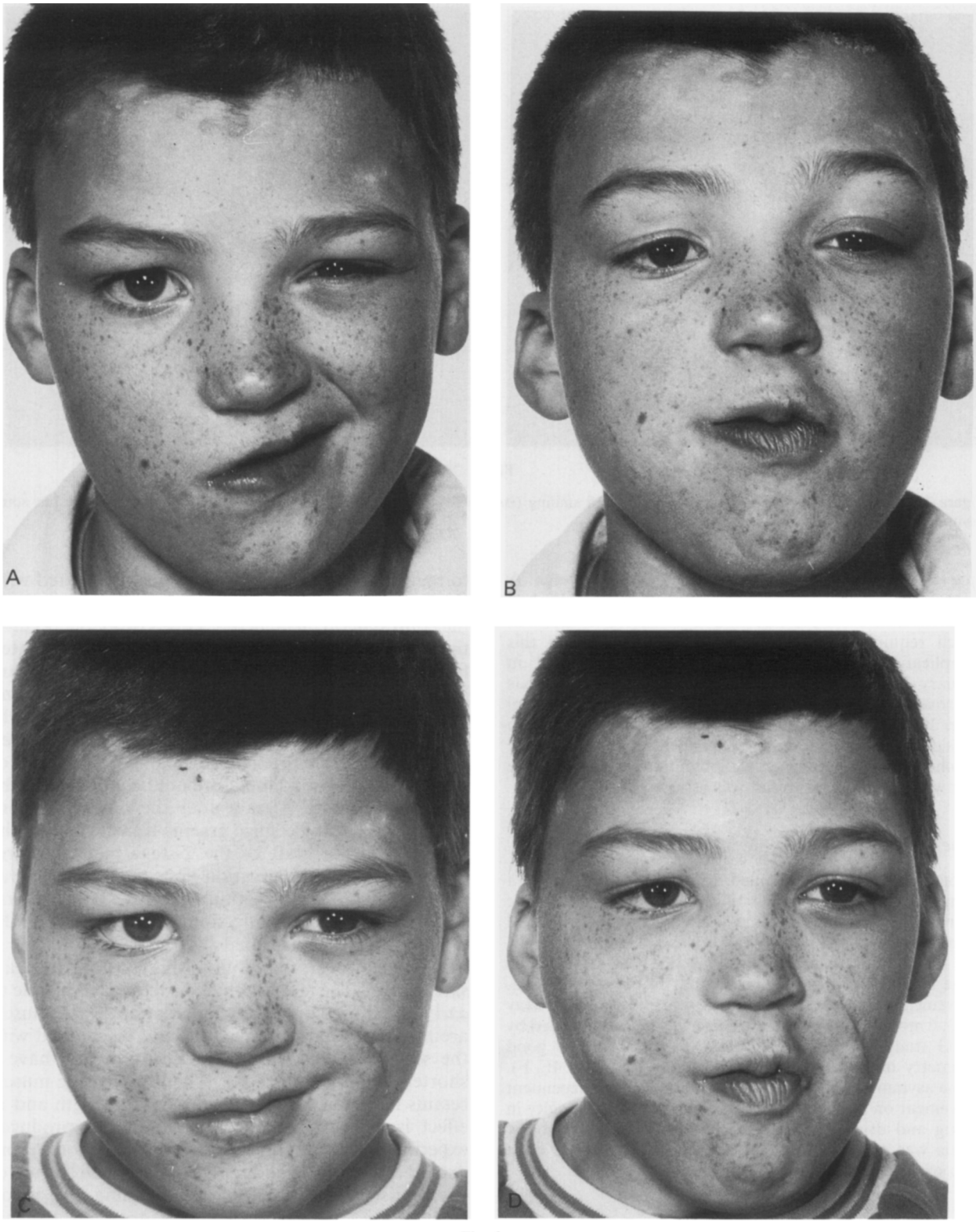

Fig. 3

Figure 3—*Case 2.* Preoperative views, while smiling (A) and blowing (B). Note marked asymmetry of the mouth while smiling. Postoperative views of the same patient while smiling (C) and blowing (D). Note improved symmetry while smiling and contraction of the transferred muscle while blowing.

for reconstruction in elderly patients in whom a 2 stage reconstruction is inappropriate.[10] When a motor nerve other than the facial nerve is used, it results in uncontrolled involuntary movements, especially when chewing, and can be distressing to most patients. The single stage gracilis transfer method of cross face reanimation is preferable to single stage methods which utilise a nerve other than the facial nerve, because it it not only restores muscle tone but also involuntary emotional movements. It also does not

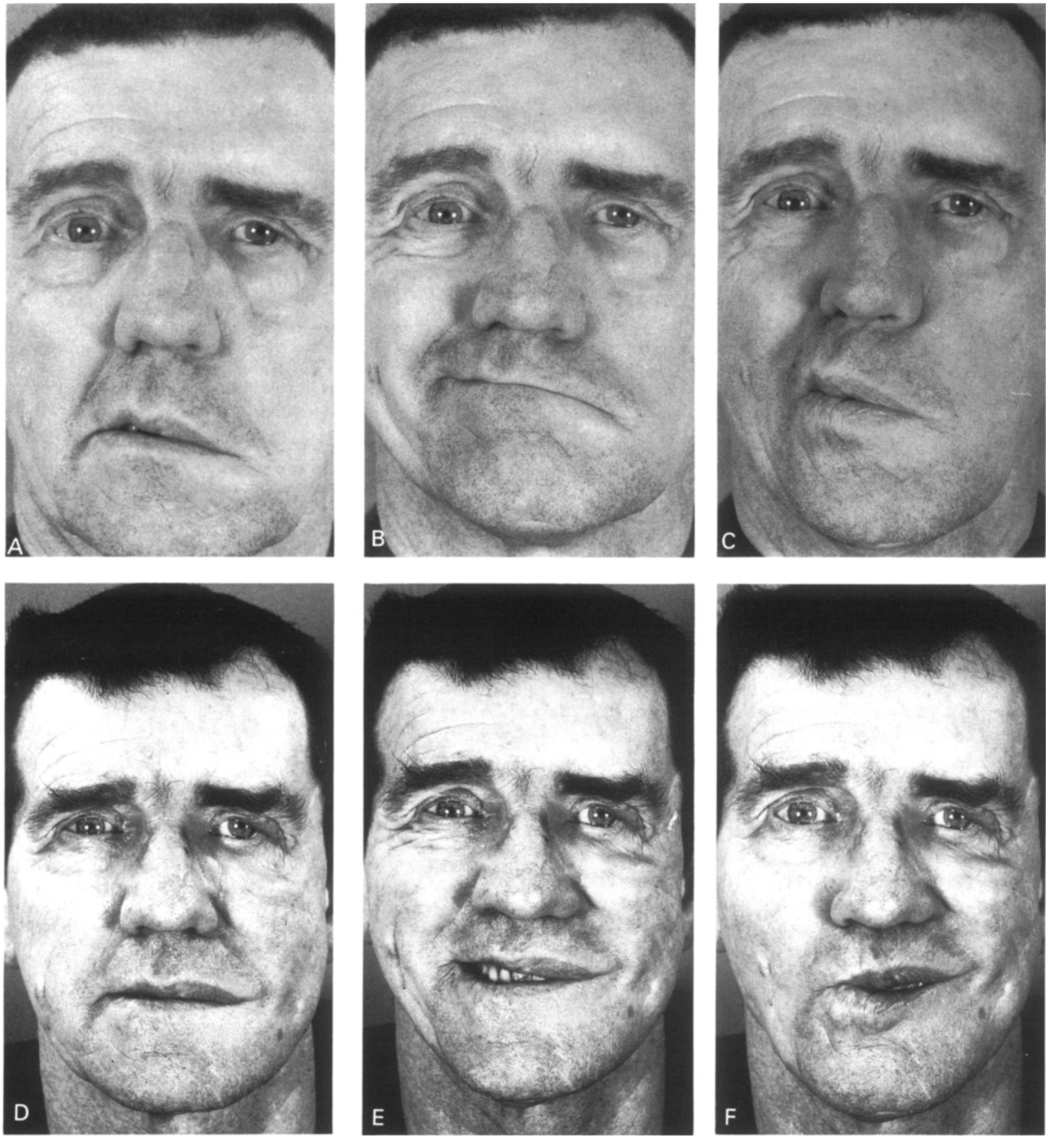

Fig. 4

Figure 4—*Case 3.* Preoperative views at rest (A), smiling (B) and blowing (C). Note asymmetry of the mouth and deviation of the lip to the nonparalysed side while smiling and blowing. Postoperative views of the same patient at rest (D), smiling (E) and blowing (F). Illustrates excellent symmetry at rest, improved symmetry while smiling and blowing. Note the lip does not deviate to the nonparalysed side.

cause distressing uncontrolled involuntary contractions. It is suitable for older patients, who do not often accept the two-stage reconstruction because of the delay. They often undergo reconstruction by less satisfactory method such as static or dynamic slings. Age alone should not be a contraindication to reanimation by free muscle transfer. The best result with the single stage technique was in a 56-year-old man (Case 3).

Rubin reported that the most common types of smile are the zygomaticus major (67%) and canine smile (31%), in which the dominant muscles are the zygomaticus major and the levator labii superioris respectively. The transferred muscle used to replace the predominant "smile" muscle should therefore be placed medially and vertically.[18] If the muscle is so placed, then all the muscles currently used for reanimation of the face are too big and have to be reduced. The internal neurovascular anatomy of the gracilis permits harvesting a small functional unit on its

neurovascular pedicle.[19] The dissection into a smaller unit can be done with the gracilis still attached to the thigh, thereby reducing the ischaemia time. The muscle is so thinned that when transferred to the face it restores facial contour without excessive bulk. Secondary thinning of the muscle is rarely, if ever, required.

One drawback of the single stage method is the scar on the anterior cheek. In the older patient the scar is fine and well camouflaged in the skin creases (Case 3; Fig. 4D–F). In the younger patient (Case 2; Fig. 3C, D), the scar may hypertrophy. Although it settled with time, the scar remains stretched and may require revision. The scar may also become tethered (Case 1; Fig. 2A, B), resulting in a dimple on animation.

O'Brien *et al.* first attempted cross-face reanimation in a single stage, using the extensor digitorium brevis muscle with the anterior tibial nerve tunnelled across the upper lip and anastomosed directly to the contralateral facial nerve.[4] The muscle survived but failed to reinnervate. The extensor digitorium brevis muscle is unsuitable because of its unreliable blood supply and because the deep peroneal nerve is both motor and sensory and inadequate numbers of fascicles reach the motor end plates.[4] The gracilis muscle does not have these disadvantages and is suitable for single stage cross face reanimation. Other muscles such as the latissimus dorsi and serratus anterior may also be suitable for single stage transfer. I prefer the gracilis because it is easier to thin with the muscle in situ; moreover, it permits operating with two teams without the need to reposition the patient.

This single stage technique for cross-face reanimation of the paralysed face without nerve graft is an improvement over current methods because it results in early reinnervation of the transferred muscle and reduces the period of rehabilitation. The preliminary results with this technique are comparable to those of the two-staged method. The single stage method is probably the way forward in facial reanimation surgery but further experience with the method is necessary.

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Paper received 19 July 1994.
Accepted 11 October 1994, after revision.