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Irreversible muscle contracture after functioning free muscle transplantation using the ipsilateral facial nerve for reinnervation

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SUMMARY. **Four patients who underwent functioning free muscle transplantation (FFMT) for facial reconstruction developed a progressive disfiguring muscle contracture. This complication has not been previously reported. Three of the patients had longstanding facial paralysis and were reanimated by FFMT. The fourth patient had left hemifacial atrophy but without facial paralysis. She also underwent FFMT for augmentation. All four FFMTs were innervated by the ipsilateral facial nerve. Initially, they all had a normal facial appearance at rest during the first few months after FFMT. However, they all developed a progressive severe muscle contracture from 6 to 12 months after FFMT. Continuous spontaneous electrical impulse activity, which stimulated the transferred muscle day and night, may be responsible for the progressive muscle contracture. From the patients' reported sensations and from clinical evaluation, which included a local xylocaine injection test, over-reinnervation with a synkinesis effect of the transferred muscle is hypothetically the main cause, not over-tension of the muscle itself. This complication may possibly be avoided by limiting or decreasing the number of fascicles from the ipsilateral facial nerve or better by using a cross-facial nerve graft instead of the ipsilateral facial nerve as the innervating motor nerve. The outcome with a cross-facial nerve is likely to be more predictable and reliable.**

Functioning free muscle transplantation (FFMT) to provide facial reanimation is an established technique in the reconstruction of patients with facial paralysis.[1–10] The literature, however, is unclear on the long-term results obtained when the ipsilateral facial nerve is used as the innervating motor nerve.

Materials and methods

Twenty-six cases of FFMT for facial paralysis were reviewed over a 7-year period (1986–1992). Of this group, 3 patients with longstanding facial paralysis due to facial nerve injury following tumour ablation were treated with FFMT using the ipsilateral facial nerve, with or without an interpositional nerve graft, as the innervating motor nerve. All three patients developed a significant postoperative muscle contracture and requested revision.

In progressive hemifacial atrophy (Romberg's disease), the use of a FFMT alone for facial augmentation has not been previously reported.[11–15] One patient with hemifacial atrophy but without facial paralysis was treated with a FFMT. She also developed a significant postoperative muscle contracture and finally requested revision.

Case reports

Case 1

A 26-year-old woman was referred with progressive wasting of the left side of her face. She had a normal appearance during childhood and her atrophy started during her teenage years and became progressively worse over a 3-year-period. After that, it remained stable for 2 years. She was concerned about her facial asymmetry (Fig. 1A). Physical examination revealed atrophic changes involving not only the left side of the face but also her left upper limb and back. A free gracilis muscle was used for facial augmentation and it was innervated to minimise muscle atrophy. The zygomatic and buccal branches of the left ipsilateral facial nerve were coapted to the motor nerve of the gracilis. The superficial temporal vessels were used for microvascular anastomoses. Her postoperative course was uneventful. Three months later, although the transferred muscle started twitching, her facial appearance remained good (Fig. 1B). Ten months postoperatively, however, a severe muscle contracture developed (Fig. 1C) and she asked for release of the contracture. Exploration of the transferred muscle revealed normal muscle morphology, macroscopically. The distal insertion into the dermis of the upper lip was released and a de-epithelialized groin flap was used to provide release and further soft tissue augmentation one year following the original muscle transplantation. She obtained considerable improvement of the facial tightness (Fig. 1D).

Case 2

A 15-year-old boy was referred with a 10-year history of left facial paralysis following numerous procedures, including a free forearm flap for inner lining of oral mucosa, for congenital lymphangioma of the left neck

Fig. 1

Figure 1—(A) A 26-year-old woman with progressive left facial atrophy (Romberg's disease). (B) Three months after gracilis FFMT for facial augmentation. (C) Ten months postoperatively—note severe muscle contracture. (D) Appearance of patient smiling after release of contracture and further augmentation by de-epithelialized groin flap. She obtained considerable improvement of the left facial tightness.

and cheek. The lower trunk of the facial nerve was injured at his last operation and he developed a left lower facial paralysis (Fig. 2A). A functioning free gracilis muscle transplantation was done to reanimate his face. The proximal stump of the lower trunk of the facial nerve was identified in the preauricular region. The transferred gracilis was fixed to the temporalis fascia proximally and to the dermis of the upper lip distally. The facial artery and veins were used for microvascular anastomoses. The motor nerve to the gracilis (obturator nerve) was coapted directly to the stump of the lower trunk of the facial nerve without a

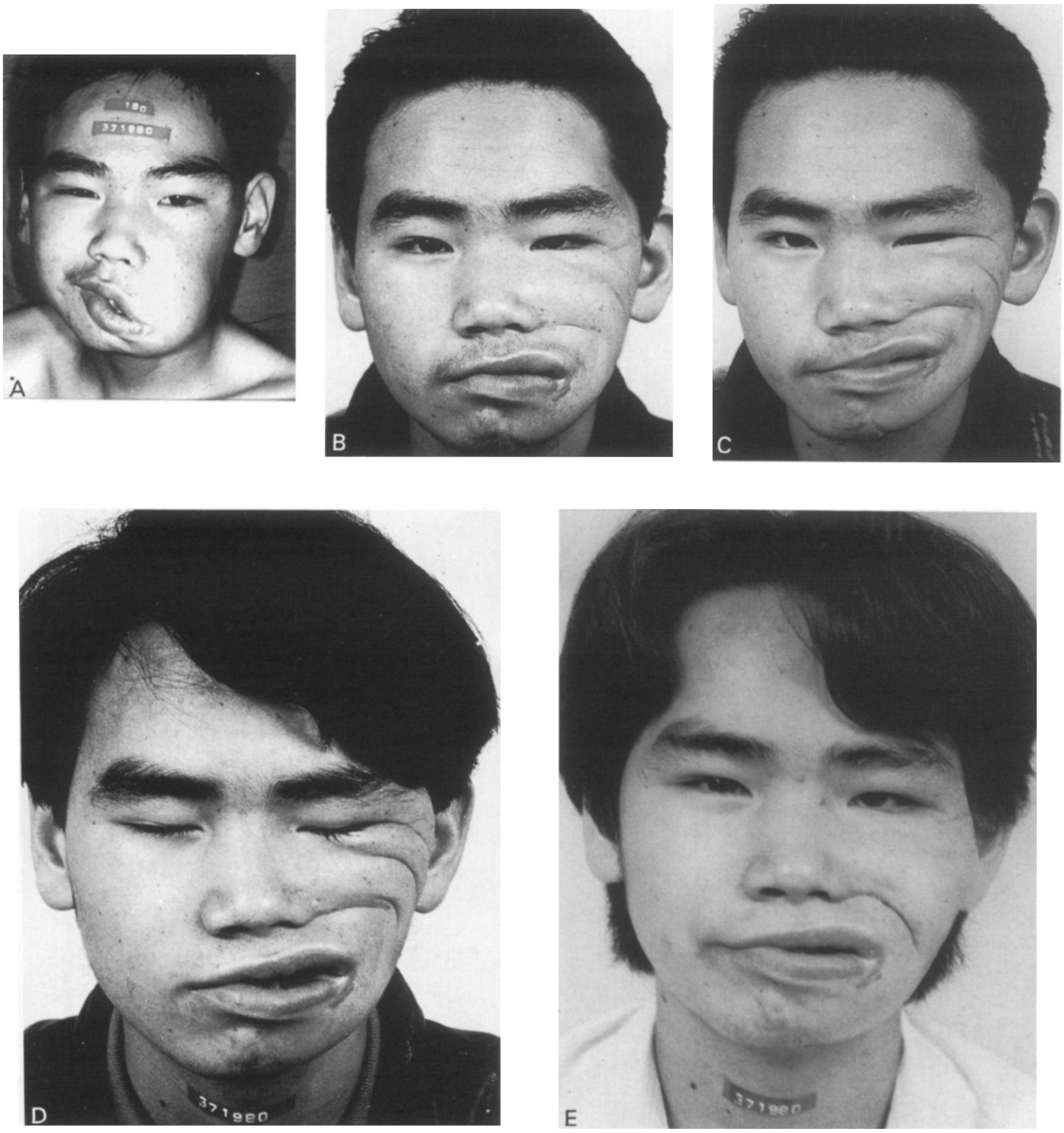

Fig. 2

Figure 2—(A) A 15-year-old boy with left facial paralysis (middle and lower face) following facial nerve injury. (B, C) Six months after gracilis FFMT he developed a muscle contracture (B: rest; C: voluntary contraction). (D) Worse facial contracture one and a half years after gracilis FFMT. (E) Appearance after secondary revision.

nerve graft. The postoperative course was uneventful. Electrical stimulation was started 3 weeks after muscle transfer. Four months later, the transferred muscle started contracting with an improved facial appearance at rest. Six months postoperatively, the transferred muscle developed a contracture (Fig. 2B–C), which became worse (Fig. 2D). Twenty months after FFMT, a secondary revision procedure became necessary; this involved detaching the proximal muscle attachment and resurfacing the muscle with a dermis-fat graft to eliminate the abnormal facial creases. This produced some improvement (Fig. 2E).

Case 3

A 20-year-old woman had a left facial paralysis (Fig. 3A) following resection of an infraauricular haemangioma when she was 1 year old. She presented 19 years later. A mastoidectomy was performed initially to retrieve the remaining proximal stump of the facial nerve in the facial canal. Elongation of the facial nerve with a sural nerve graft from the facial canal to the left nasolabial fold was performed as the first stage of reconstruction. The Tinel's sign advanced from the mastoid process to the nasolabial fold (Fig.

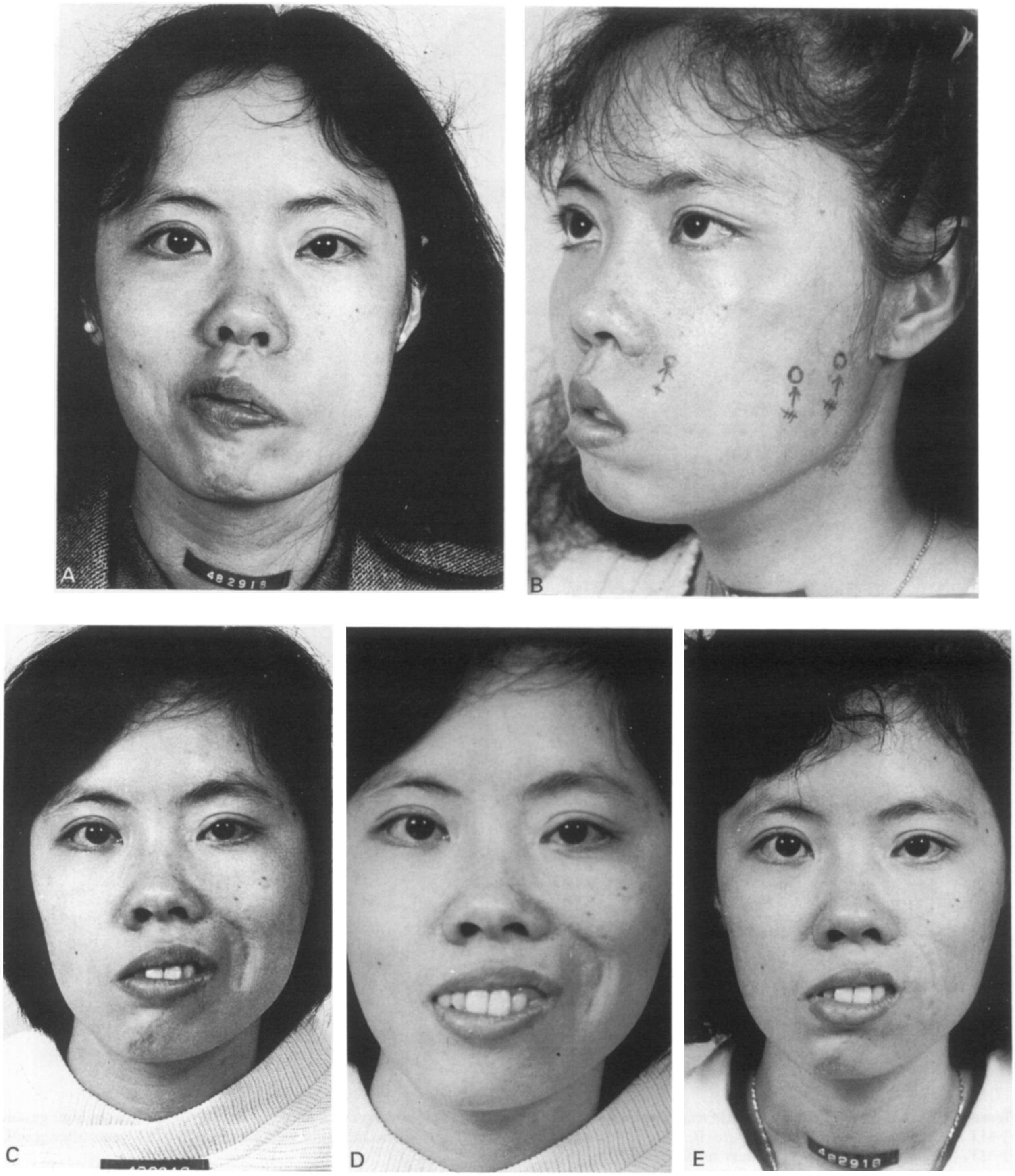

Fig. 3

Figure 3—(A) A 20-year-old woman with complete left facial paralysis following facial nerve injury. (B) Preliminary nerve graft inset from the left facial canal to the nasolabial fold. Note progressive Tinel's sign (→0). (C, D) Six months postop FFMT, muscle contracture present (C: rest; D: voluntary contraction). (E) Appearance after secondary revision—elongation of the distal attachment of the transferred muscle with fascia lata.

3B). A gracilis FFMT, with the nerve graft as the innervating motor nerve, was performed 9 months later as the second stage. The patient underwent routine electrical stimulation. Six months after the transplantation, although she was able to contract the transferred muscle, the muscle persisted in a contracted state even when she attempted to relax (Fig. 3C–D). A secondary revision procedure was necessary, with detachment of the distal muscle insertion and elongation with fascia lata and further soft tissue augmentation with a free fat graft. She felt this surgery improved the facial tightness (Fig. 3E).

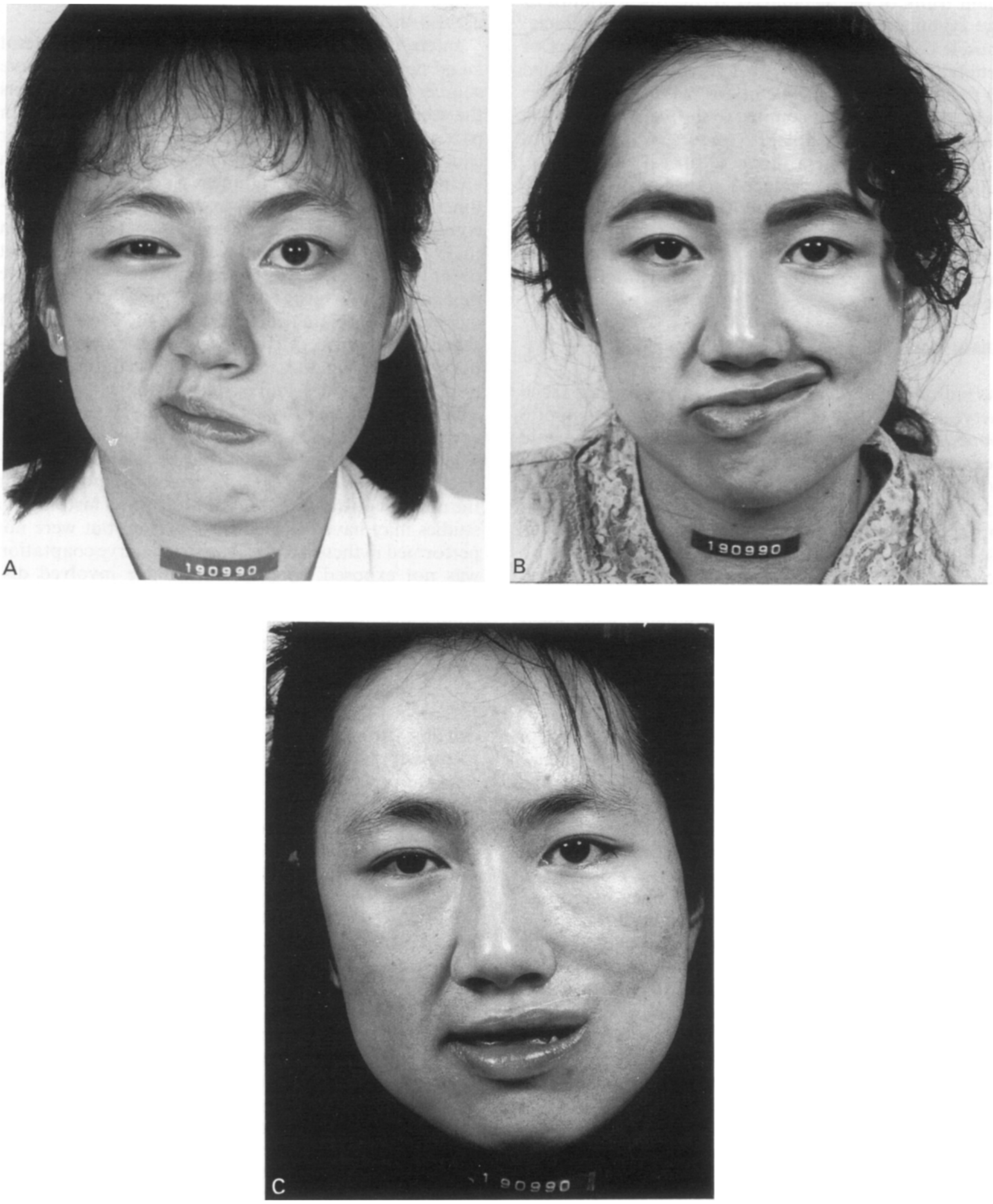

Fig. 4

Figure 4—(A) A 20-year-old woman with a complete left facial paralysis following facial nerve injury. (B) She developed a left face muscle contracture after the gracilis FFMT. (C) Appearance after secondary revision by elongation of the distal attachment with fascia lata.

Case 4

A 20-year-old woman had a longstanding complete left facial paralysis following resection of a lymphangioma in the left preauricular region as an infant (Fig. 4A). Preliminary exploration of the stylomastoid foramen was carried out to locate the main trunk of the facial nerve, which was found at this site and traced distally. Dense scar over the masseter muscle was noted. The distal stump of the zygomatic and buccal branches of the facial nerve were identified. Two nerve grafts were used to connect the proximal main trunk of the facial nerve to the distal stumps of the zygomatic and buccal branches. Very little facial muscle contraction was evident even after 4 years of rehabilitation. So FFMT with gracilis was performed to reanimate her face. The motor nerve of the gracilis (obturator nerve) was coapted to the main trunk of the facial nerve. Her postoperative course was uneventful and she underwent routine electrical stimulation. Unexpectedly, she developed a progressive muscle contracture 8 months later (Fig. 4B). Secondary revision with detachment of the distal muscle insertion and elongation with fascia lata was performed to correct the contracture and produced improvement (Fig. 4C).

Discussion

As indicated by May,[16] spatial orientation of the facial nerve fibres exists in the nerve within the temporal bone, the stylomastoid foramen and the parotid segment of the facial nerve trunk. The fibres destined for each peripheral branch are actually diffusely located in the facial nerve trunk, at least as far proximally as the tympanic segment of the facial canal. So it is understandable why nerve regeneration following injuries to the facial nerve usually results in some degree of mass movement and synkinesis. Hakelius[17] reported that some patients with Bell's palsy develop a spastic paralysis and in those patients a free muscle transfer (nonvascularised) will increase the spasticity. Stranc[18] reported a patient who developed accidental reinnervation 3 years after a latissimus dorsi free flap transfer and skin graft for treatment of traumatic total scalp loss. An anastomosis between the nerve to the latissimus dorsi and the upper branch of the facial nerve was found to have developed. Miehlke *et al.*[19] proposed that traumatic injury to the facial nerve could produce a contracture due to aberrant regeneration following either spontaneous healing or surgical repair. They mentioned that secondary defects such as synkinesis, facial spasm, crocodile tears and contractures can only develop when sufficient numbers of axons grow out peripherally. The same phenomenon could occur with the use of the ipsilateral facial nerve as the motor source to reinnervate a transferred muscle. Persistent impulses from co-innervation of temporal, zygomatic, buccal, mandibular and cervical branches could stimulate the transferred muscle frequently and thus cause a permanent contracture.

The free muscle transfers in our four cases were all performed with the same technique. A preauricular incision and a careful face-lift were made. Dissection of the facial nerve from the main trunk antegradely was done carefully to find the planned innervating nerve. Ipsilateral gracilis muscle was used as the FFMT. The full width of gracilis muscle, 12–14 cm in length, was transferred according to the length measured preoperatively from the lower temporal fossa to the upper lip. Intraoperatively, the upper end of the muscle was fixed to the temporal fascia and the lower end was anchored to the dermis of the upper lip. The muscle was usually under tension to expose the lower portion of the 2nd incisor or canine teeth, similar to the technique we use in cases of cross-facial nerve graft followed by FFMT.

Interestingly, in all these four cases the ipsilateral facial nerve was used as the innervating motor nerve source. The main complaint in these four patients was the feeling of progressive tightness of the muscle. In particular, sudden emotional feelings such as fear caused the angle of the mouth to be pulled higher with an increasing feeling of tightness. Surprisingly, around times of sleep patients were also aware of an uncomfortable tightness in the reconstructed face when they intended to close their eyes. This tightness did not occur in our other 23 cases with cross-face nerve innervation. A local anaesthetic injection such as xylocaine at the anterior margin of the lower pole of the mastoid process can relieve the tightness temporarily. During the secondary procedures, all the transferred muscles looked macroscopically normal. Therefore, the main problem of the postoperative contracture was not intrinsically within the muscle. The innervating nerve itself and excessive reinnervation of the muscle appear to be mainly responsible for the muscle contracture. Muscle biopsy and histological studies may have clarified the situation but were not performed in these 4 cases. The site of nerve coaptation was not exposed, as this would have involved dissection through scar tissue near the nerve, with consequent risk of injury to the nerve. Even if it were possible to identify the site of nerve coaptation, it would still be impossible to decide how many fascicles should be sectioned. Hence, we preferred to perform a palliative procedure by sliding the muscle from its proximal attachment or lengthening the distal attachment with fascia lata. The subjective feeling of tightness did improve after this secondary surgery.

In the reconstructive procedure of cross-facial nerve graft followed by FFMT to treat unilateral facial paralysis, there is also the possibility of this problem of muscle contracture. O'Brien *et al.*[8] in their 69 patients with long-term facial palsy treated by cross-facial nerve grafting followed by FFMT, simply noted, without giving any explanation, that there were 28 patients who needed release of the muscle as a secondary procedure. Sassoon *et al.*[10] in their 12 long-term cases (2–9.5 years after gracilis muscle transfer, preceded by cross-face nerve grafting), found that there were more motor nerve fibres innervating the muscle by continuing motor nerve fibre regeneration, rather than terminal sprouting of axons which had already reached the muscle 4 years previously. Poole[20] has also observed such a case of muscle contracture, after surgery with a cross-facial nerve graft followed by a latissimus dorsi muscle transfer; he had to do a further operation to denervate the muscle centrally, as it had caused a very ugly contracture. In our series of 23 cases of facial paralysis treated by FFMT preceded by a cross-facial nerve graft, our patients have not been found to have this problem of a feeling of progressive tightness and have not asked for secondary revision.

Using FFMT to augment Romberg's disease with hemifacial atrophy has not previously been reported, to the best of our knowledge. Our one case showed clearly the problem of progressive postoperative muscle contracture instead of the intended augmentation. Therefore, an FFMT to augment the atrophic face using branches of the ipsilateral facial nerve to avoid atrophy of a denervated transferred muscle is not a good reconstructive option. The transferred muscle will possibly not only decrease in size tremendously, for no known reason, but also cause a facial contracture.

Clearly prevention is better than cure. Harii[3] reported an interesting finding in his preliminary paper. Atrophy was greater in the transferred gracilis muscle in which only one fascicle of the motor nerve was restored, compared to several fascicles. This suggests that limiting the number of axons growing down the nerve would decrease the extent of muscle fibre reinnervation and this could be achieved either by using only part of the facial nerve as the innervating motor nerve, or using only a part of the motor nerve of the transferred muscle for reinnervation. The other option is to use a cross-facial nerve graft, no matter whether the ipsilateral facial nerve is available or not. The incidence of muscle contracture producing post-operative morbidity following FFMT innervated by cross-facial nerve grafts is still low. We therefore recommend using a cross-facial nerve graft followed by functioning free muscle transplantation for facial animation, even when the ipsilateral proximal stump of the injured facial nerve is still available.

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