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CASE REPORT

Reanimation of reversible facial paralysis by the double innervation technique using an intraneural-dissected sural nerve graft

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Summary In treating reversible facial paralysis, cross-facial nerve grafting offers voluntary and emotional reanimation. In contrast, rapid re-innervation and strong neural stimulation can be obtained with hypoglossal-facial nerve crossover. In this article, we describe the method of a combination of these techniques as a one-stage procedure. A 39-year-old man presented with facial paralysis due to nerve avulsion within the stylomastoid foramen. The sural nerve was harvested and two branches were created at its distal end by intraneural dissection. One branch was anastomosed to the contralateral facial nerve, and the other branch was used for hypoglossal-facial nerve crossover, followed by connecting the proximal stump of the graft to the trunk of the paralysed facial nerve in an end-to-end fashion. At 9 months postoperatively, almost complete facial symmetry and co-ordinated movements of the mimetic muscles were obtained with no obvious tongue atrophy. Since our method can efficiently gather neural inputs from the contralateral facial nerve and the ipsilateral hypoglossal nerve, it may become a good alternative for reanimation of reversible facial paralysis when the ipsilateral facial nerve is not available.

Cross-facial nerve grafting (CFNG) and hypoglossal-facial nerve crossover (HFNC) have become the standard operative options for early facial reanimation when the proximal stump of the facial nerve on the affected side is not available.[1—3] Although CFNG can offer a more voluntary and emotional facial animation as compared with HFNC, the long regeneration period in CFNG may result in irreversible atrophic changes of the mimetic muscles. In contrast, HFNC

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offers a more rapid re-innervation and powerful stimulation than CFNG while the co-ordinated facial animation is difficult to achieve. To resolve the disadvantages of each procedure, a combination of these two operations, known as 'baby-sitting procedure', has been reported as a two-stage procedure.[4–7] However, there are few reports on the one-stage procedure using CFNG and HFNC, which can offer several advantages. In this report, we describe a method of combining CFNG and HFNC as a one-stage procedure using an intraneural-dissected sural nerve graft.

Case report

A scaffolding pipe stuck into a 39-year-old man's face at a construction site, penetrating his left lower orbit to reach the posterior mastoid process (Figure 1, upper). After the pipe was removed by the neurosurgery team using an embolisation technique under general anaesthesia, the patient presented with a left facial paralysis due to nerve avulsion within the stylomastoid foramen. An attempt to interpose the nerve gap with a great auricular nerve graft on postoperative day 20 proved unsuccessful (Figure 1, lower). Eight months after the initial injury, a combination of CFNG and HFNC as a one-stage procedure was carried out under general anaesthesia.

After extending the postauricular incision downward to the submandibular region on the affected side, the facial nerve trunk distal to the previous interpositional graft and the hypoglossal nerve were exposed. On the unaffected side, a small incision was made below the zygoma, and the two divisions of the zygomaticobuccal branch were dissected. Then, a 25-cm-long sural nerve graft was harvested, and two branches were created at the distal end of the graft using an intraneural dissection technique under the microscope.[8] After this procedure, the graft had two branches at its distal end, and one main trunk at its proximal end (Figure 2, upper). One branch at the distal end of the graft (with two fascicles) was tunnelled across the upper lip in a reversed fashion, and this branch was further

Figure 1 A scaffolding pipe stuck into a 39-year-old man's face, resulting in total left facial palsy. (Upper) The pipe penetrated his left lower orbit to reach the posterior mastoid process. (Lower) Appearance at 6 months after injury at rest (left) and during smiling (right).

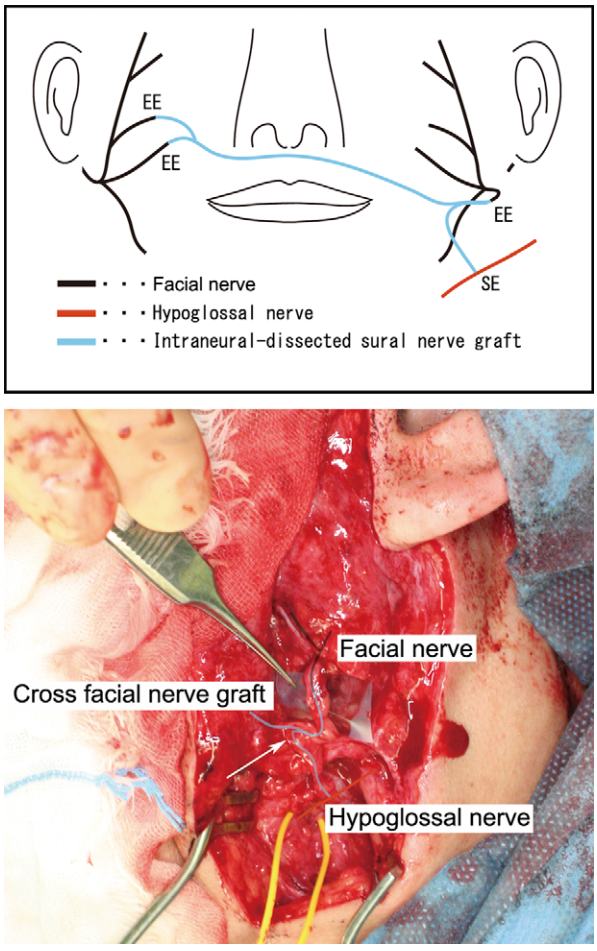

Figure 2 One-stage cross facial nerve grafting and hypoglossal-facial nerve crossover were performed 8 months after injury. (Upper) A schematic illustration of the procedure is shown. Intraneural-dissected sural nerve graft was used with 3 end-to-end neurorrhaphies (EE) and one side-to-end neurorrhaphy (SE). (Lower) An intraoperative view on the affected side is shown. The tip of the forceps; end-to-end neurorrhaphy site between the main trunk of the graft and the paralysed facial nerve, white arrow; bifurcation of the dissected sural nerve graft.

divided into two fascicles followed by anastomosis to the identified zygomaticobuccal branches on the unaffected side in an end-to-end fashion. On the affected side, the other branch at distal end of the graft was anastomosed to the hypoglossal nerve in a side-to-end fashion using 30–40% partial neurectomy technique.[3] At this stage, additional intraneural dissection could be performed to obtain the shortest way from the hypoglossal nerve to the facial nerve. Finally, an end-to-end neurorrhaphy was carried out between the proximal end of the graft and the paralysed facial nerve (Figure 2). To re-innervate the whole mimetic muscles, neurorrhaphy was performed before the facial nerve divides into its two main divisions.

During the whole follow-up period, rehabilitation training using mirror exercise was encouraged. The myogenic tonus of the mimetic muscles started to restore gradually at 4 months postoperatively, followed by spontaneous facial reanimation. At 6 months postoperatively, orbital floor and nasal bone reconstruction with iliac bone, and gold plate loading to the upper eyelid on the affected side were performed. At 7 months postoperatively, almost complete facial symmetry was achieved, and currently (at 9 months), the patient has regained voluntary and co-ordinated smile without tongue movement. No obvious atrophy or dysfunction of tongue is noted (Figure 3).

Electroneuromyographic examination was performed at 9 months after surgery with individual stimulation of the facial nerve on the unaffected side and the hypoglossal nerve on the affected side, independently. With each stimulation, motor action potentials were detected on the peripalpebral and perioral muscles, indicating that double innervation of the muscles with two different nerves had been successfully achieved (Figure 4).

Discussion

In treating reversible facial palsy, there are two major goals: (1) to supply a strong neural input rapidly before irreversible atrophic changes occur in the mimetic muscles and (2) to provide an appropriate neural input, which offers voluntary and emotional facial animation. When the palsy is total and the ipsilateral facial nerve is not available, a combination of CFNG and HFCN can satisfy both conditions.[4–7]

We presented herein a modification of the technique as a one-stage procedure using an intraneural-dissected sural nerve graft, which offers several merits. Most importantly, the intraneural-dissected sural nerve graft can efficiently gather motor neural input from the contralateral facial nerve and ipsilateral hypoglossal nerve. All neurorrhaphies, except for the hypoglossal nerve–sural nerve graft coaptation site, can be performed in an end-to-end fashion, which is obviously superior to end-to-side neurorrhaphy with regard to the efficiency of axonal regeneration. In 2003, Yamamoto et al. reported a case of one-stage CFNG and HFNC procedure in which direct HFNC was performed without a nerve graft, and the distal end of the cross-facial sural nerve graft was connected to the paralysed facial nerve trunk in an end-to-side fashion.[9] Although the number of anastomosis increases in HFNC with our method, we give more importance to CFNG than HFNC, based on the previous findings that only 10–20% of the original axons arrive at the distal end of the graft in CFNG in man.[10] Other minor merits of our procedure are: (1) damage of the facial nerve branches on the affected side, which is inevitable in CFNG as a two-stage procedure, can be avoided; (2) the second operation not being necessary would lighten the patients' burden; and (3) the dissection of the intratemporal facial nerve not being necessary would reduce the operation time.

However, there is a potential disadvantage of a one-stage procedure. Synkinesis may frequently occur than in the two-stage procedure. Since the sural nerve graft is connected to the facial nerve trunk in a one-stage procedure, the axons in CFNG have multiple choices in the distal pathway. In contrast, CFNG can be performed between selected branches of the facial nerve in the two-stage

Figure 3 Postoperative photographs. (Upper left) At rest, 7 months postoperatively, (Upper, right) during smiling, 9 months postoperatively. (Lower) No obvious atrophy or dysfunction of the tongue is noted.

procedure. Although minimal synkinesis was evident in our case, further clinical studies are needed to elucidate this issue.

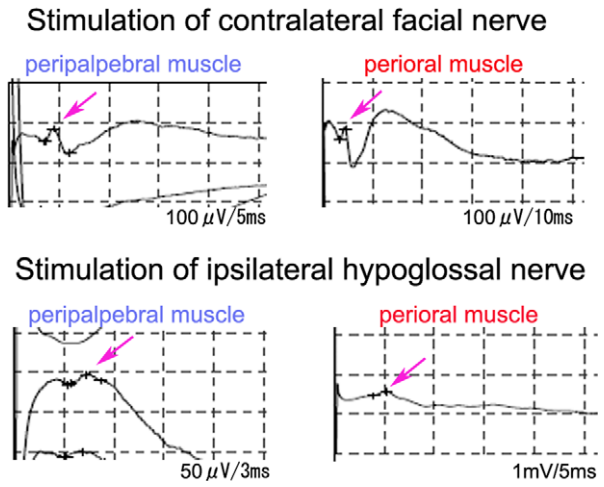

Figure 4 Electroneuromyographic examination was performed at 9 months postoperatively. Motor action potentials were detected both in the peripalpebral and perioral muscles with individual stimulation of the contralateral facial nerve and the ipsilateral hypoglossal nerve, confirming the double innervation of the muscles. The arrows indicate motor action potentials on each muscle.

A combination of CFNG and HGNC as a one-stage procedure using intraneural-dissected sural nerve graft could offer voluntary and emotional reanimation of reversible facial paralysis by efficiently gathering two different motor neural inputs. This new approach could be a good alternative when the ipsilateral facial nerve is not available.

Conflicts of interest

The authors declare no conflicts of interest.

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