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"Smile" Reconstruction in Facial Paralysis

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Reanimation of the face following facial nerve paralysis, especially the socially important smile, presents a complex surgical challenge requiring an individualized approach. Both neural and non-neural operative procedures have been used in an attempt to achieve the goal of a symmetrical synchronous smiling expression.

A retrospective review of the results of both neural and non-neural methods was made to determine the relative efficacy of various methods. Of the neural techniques, early direct nerve repair primarily consistently achieved the best functional recovery. Double nerve grafts were found to be superior to a single nerve graft in nerve severance with a nerve gap at the facial nerve trunk bifurcation in delayed cases. In long-standing cases, ipsilateral or cross-face nerve grafting followed by functioning muscle transfer gives the most acceptable synchronous smile. Although cross-face nerve graft only, hypoglossal facial transfer, or non-neural techniques such as temporal muscle transfer achieved restoration of the smile, their inconsistent results and asynchronous action still limited the patient's confidence in social interactions.

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Since Sir Charles Bell first demonstrated that the seventh cranial nerve innervates the muscles of facial expression [9], disorders of the facial nerve and their management have continued to capture the intense interest of a broad group of clinical specialists as well as basic scientists.

In 1879 Drobnik performed the first nerve transfer to reinnervate the facial muscles by completing an end-to-end anastomosis between the spinal accessory nerve and the facial nerve [26]. Loss of function of the spinal accessory nerve and limited improvement following the surgery resulted in the infrequent use of this technique. Korte first performed a hypoglossal facial anastomosis in 1901 and had a surprisingly good result [26]. Conley and Baker [7], reporting success in 137 patients in a 30-year experience with this method, have proved hypoglossal nerve transfer to be a reliable technique in facial reanimation.

Sterling Bunnell [5] in 1927 carried out the first successful facial nerve graft within the temporal bone, and later in 1937 [4] he bridged defects of the extratemporal facial nerve by a nerve graft with good results. In 1935 Dott attached a long sural nerve graft to the facial nerve stump near the brainstem, and in a second stage (90 days later) coapted the graft to the distal facial nerve near the stylomastoid foramen. He had 4 patients before 1958 and all demonstrated good results [10].

In 1938 Sir Terence Cawthorne [6] was the first to use the operative microscope for surgery of the facial nerve within the temporal bone. Ugo Fisch [11] in 1979 introduced electroneuronography to document clinically the function of the facial nerve in acute palsies. He used this study to assist in deciding whether conservative treatment or immediate facial nerve exploration should be performed.

Scaramella [24] in 1971 successfully performed a cross-face nerve graft from the intact buccal ramus to the paralyzed face. Later Smith [25], Anderyl [1], and others [12, 20] popularized this technique, which may be performed in either one or two stages.

The first combined free muscle transplantation with nerve and vessel microanastomosis was accomplished by Harii in 1976 [15] with remarkable results. Although the complicated nature of the procedures limited its usage at that time, it is now widely accepted as a result of improved technology and the improved clinical outcome. Extensor digitorum brevis [29], gracilis [14, 19], latissimus dorsi [8], pectoralis minor [16], and serratus anterior [3] muscles have been used to restore movement of the paralyzed face.

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Although Thompson [28] in 1971 reported successful transfer of a denervated muscle graft for facial reanimation without vascular anastomosis in 8 patients, this technique is not currently accepted. Tucker [30] in 1979 extended the use of the muscle-nerve pedicle technique to reanimate the paralyzed face with support from multiple animal model experiments. Its function is still limited and unpredictable.

Regional muscle transposition using the temporalis and masseter muscles have been used for many years beginning with Lexer (1908). Recent use of these techniques has been described in detail by Baker and Conley [2], Rubin [22], and Freeman [13].

Rubin presented an excellent description of the anatomy of a smile [21] and described procedures such as facial muscle plication or shortening for the paralyzed face with good results [23]. Other procedures such as suspension, face-lift, brow-lift, Z-plasty of the oral commissure, limited wedge resection of the lateral lower lip, neurectomy, myectomy, and so on are ancillary techniques that allow the primary procedures just presented to be more complete and satisfactory in smile reconstruction.

Reconstructive Procedures

Direct Nerve Coaptation

Primary nerve repair with direct nerve coaptation following facial nerve severance provides the best reanimated smile (patient 1, Fig 1A, B), but synkinesis resulting from irregular axonal growth is still one of the sequela.

Indirect Nerve Coaptation

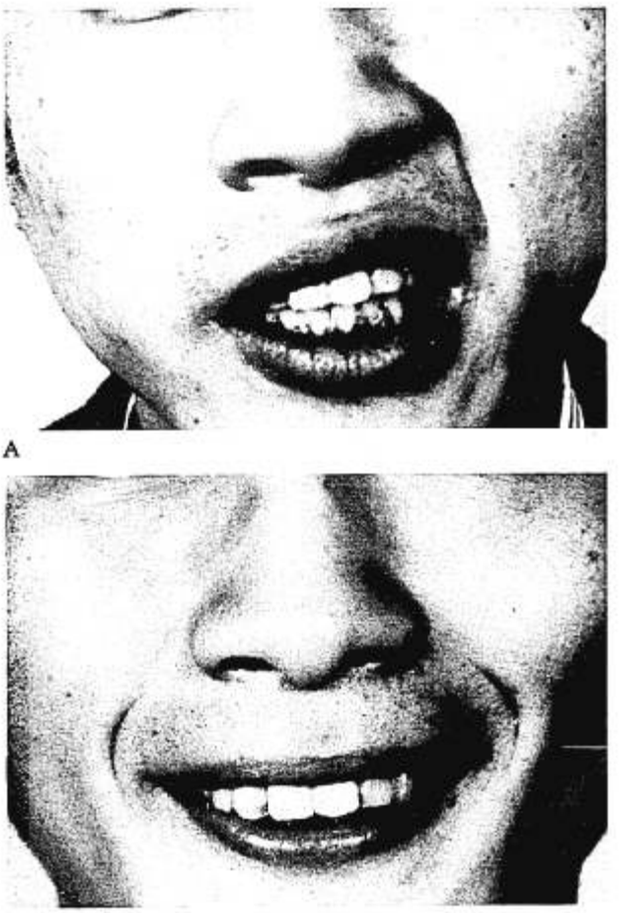
Delayed nerve repair with nerve grafts following later facial nerve severance or tumor resection can still result in a good symmetrical smile. The cross-sectional diameter of the graft may affect the results (Fig 2), and two cable grafts at the main trunk bifurcation area (patient 2, Fig 3A, B) are more successful than one graft with two terminal branches (patient 3, Fig 4A, B) in continuity.

Cross-face Nerve Graft

Cross-face nerve graft as a one- or two-stage procedure provides an inconsistent result, especially when applied in the chronic cases of the palsies (patient 4, Fig 5A, B).

Hypoglossal Facial Nerve Transfer

Hypoglossal facial nerve transfer is a simple one-stage procedure. However, the asynchronous involuntary



A

B

Fig 1. Patient 1. Preoperative (A) and postoperative (B) views of patient who underwent direct nerve coaptation following facial nerve severance for two days.

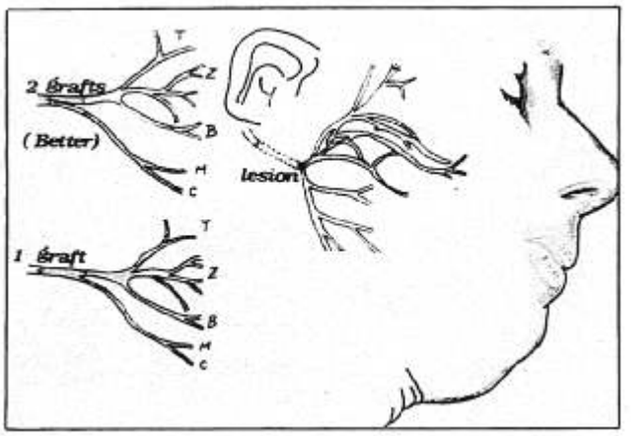


Fig 2. Two cable grafts at the main trunk bifurcation area are better than one graft with two terminal branches.

smiling with mass movement is pronounced (patient 5, Fig 6A, B) and overestimated. Yet for the aged patient, it may yield an improved smile (patient 6, Fig 7A, B). The main reason is that skin relaxation in the aged patients can neglect the mass movement.

Temporalis Muscle Transfer

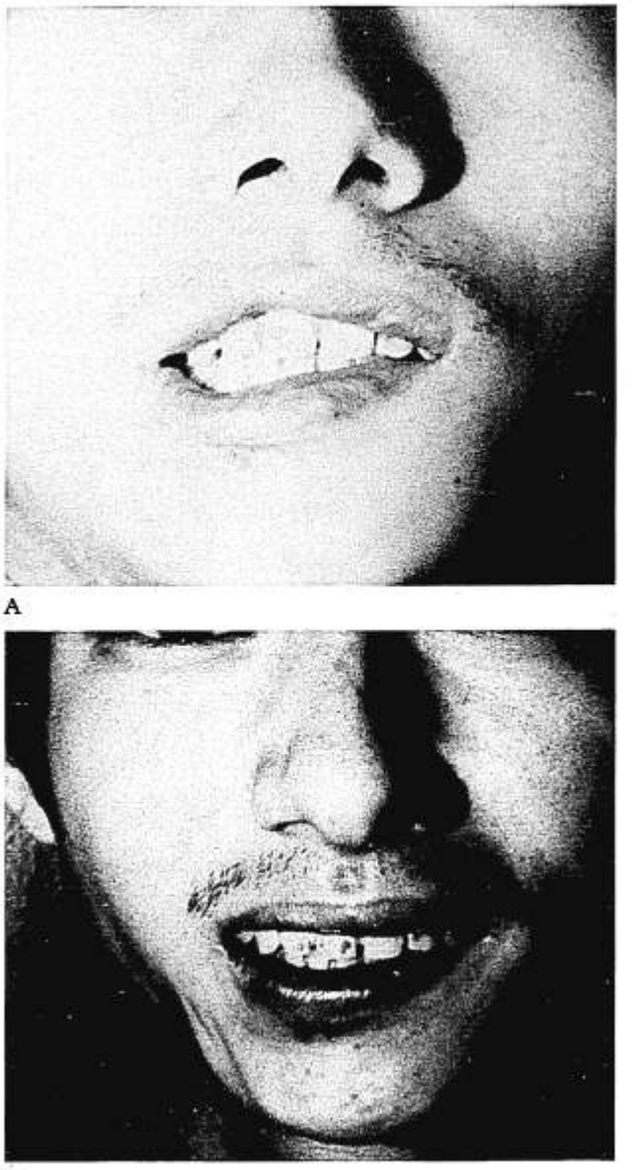
Temporalis muscle transfer in long-standing facial paralysis seems more effective for eye closure, but does result in some improvement of the smile (patient 7, Fig 8A, B).

Shortening or Plication

Shortening or plication of weakened facial muscles in cases of long-standing partial facial paralysis can improve the appearance by giving the patient a more natural appearing smile (patient 8; Fig 9A, B; patient 9, Fig 9C, D).

Free Muscle Graft

Free muscle transplantation with microneurovascular anastomosis with ipsilateral nerve graft (patient 10, Fig 10A, B) or with cross-face nerve graft (patient 11, Fig 11A, B) for chronic long-standing cases gives the patient an impressive and natural smile.



A

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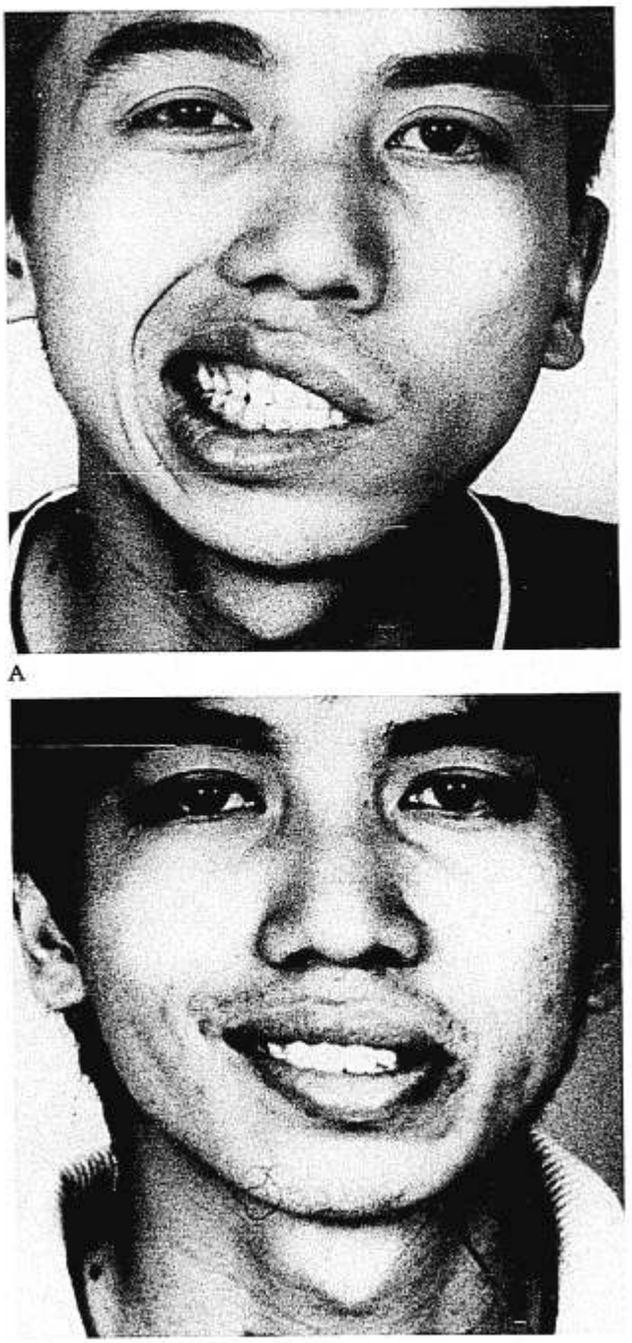
Fig 3. Patient 2. Preoperative (A) and postoperative (B) views of patient who underwent two cable grafts following facial nerve severance at the main trunk for three months.



A

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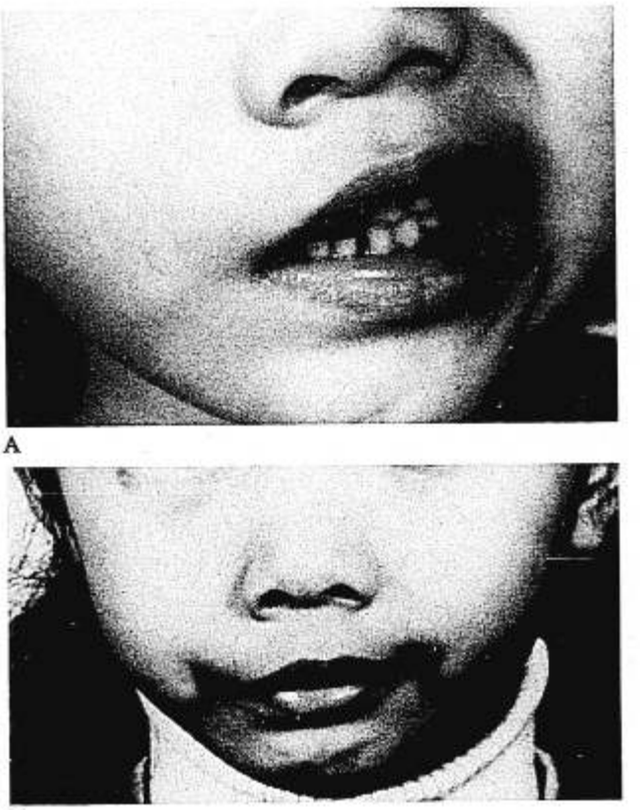
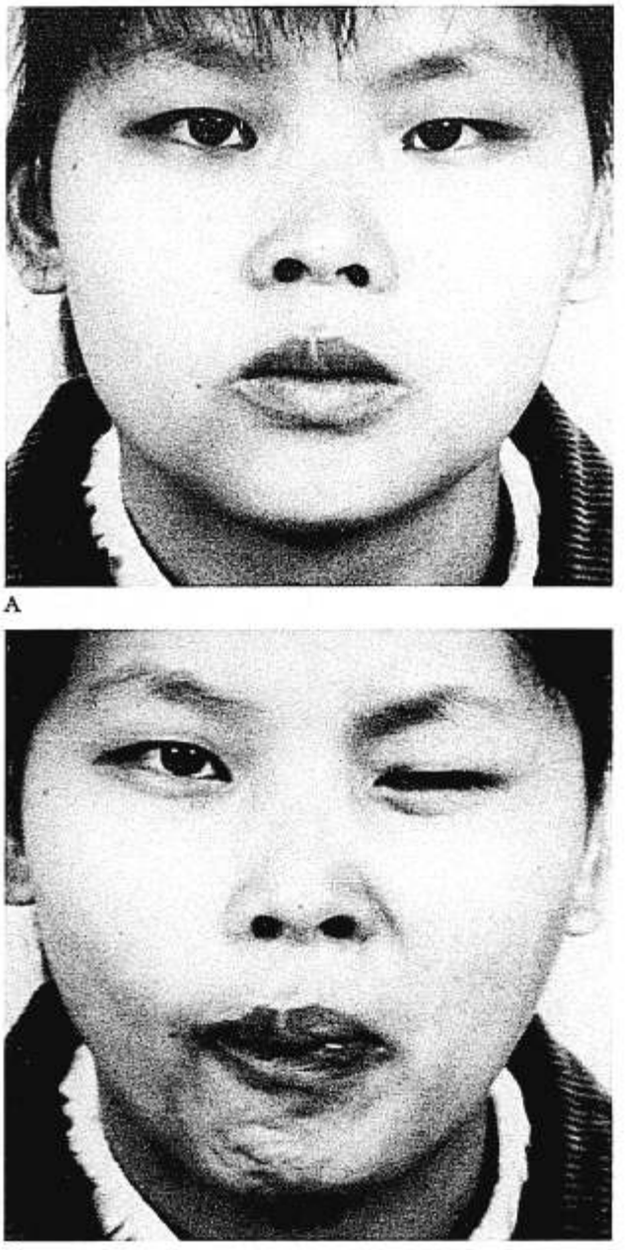
Fig 4. Patient 3. Preoperative (A) and postoperative (B) views of patient who underwent one graft with two terminal branches following neurofibroma of facial nerve resection at the main trunk for three months.



A

B

Fig 5. Patient 4. Preoperative (A) and postoperative (B) views of patient who underwent cross-face nerve graft following tumor resection for one and one-half years.

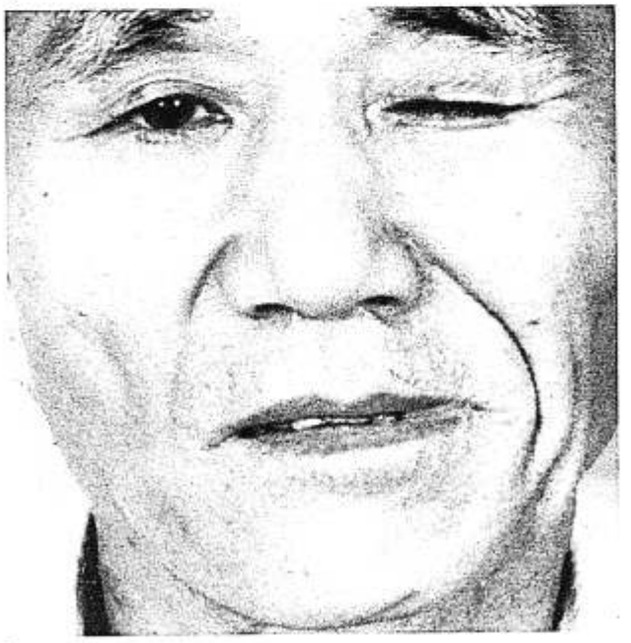


A

B

Fig 6. Patient 5. Preoperative (A) and postoperative (B) views of patient who underwent hypoglossal facial nerve transfer following acoustic neuroma resection for one-half year. Note the undesirable mass movement in the postoperative view.

A



B

Fig 7. Patient 6. Preoperative (A) and postoperative (B) views of patient who underwent hypoglossal facial nerve transfer following acoustic neuroma resection for one year.

A

B

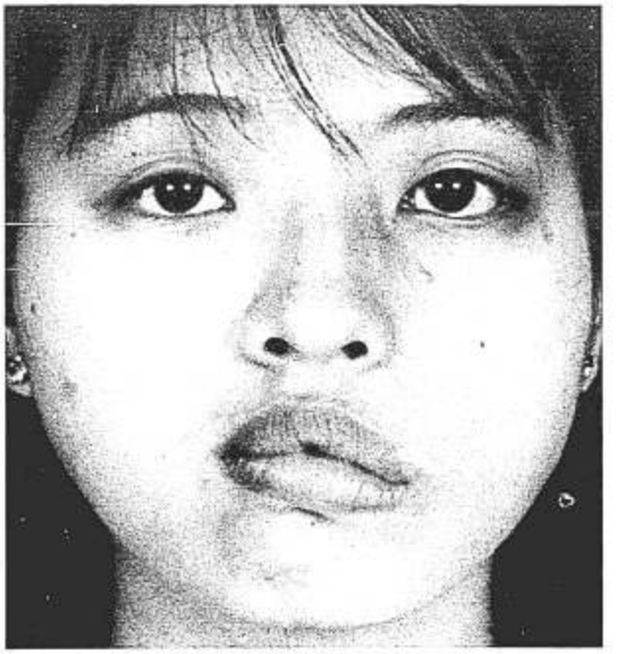
Fig 8. Patient 7. Preoperative (A) and postoperative (B) views of patient who underwent temporalis muscle transfer following acoustic neuroma resection for one year.

Fig 9. Plication and myectomy were performed for incomplete, long-standing facial paralysis in patient 8 (A, preoperatively, and B, postoperatively) and in patient 9 (C, preoperatively, and D, postoperatively).

A

B

Fig 10. Patient 10. Preoperative (A) and postoperative (B) views of patient who underwent free gracilis muscle flap following cross-face nerve graft after chronic long-standing paralysis for 20 years.



A

B

Fig 11. Patient 11. Preoperative (A) and postoperative (B) views of patient who underwent free gracilis muscle flap following ipsilateral nerve graft after facial nerve tumor resection at stylomastoid foramen for two years.

Discussion

The ideal smile reconstruction should (1) be symmetrical, (2) be synchronous (voluntary or involuntary), (3) have rapid restoration to normal facial tones, and (4) have no important loss of function at the donor site.

Numerous techniques of facial reanimation have been advocated in the past. They can be classified into two major types of operative procedures: neural and non-neural. Neural procedures include direct nerve coaptation, nerve grafts, cross-face nerve grafts, nerve transfer, nerve decompression, and microneurovascular free muscle transfer. Non-neural reconstruction includes regional muscle transfer, metal springs, Silastic bands (Dow Corning Corp., Midland, MI), fascial suspension, sphincter reconstruction of the mouth, Z-plasty of the lip, myectomy, and face-lift, for example. No single procedure can cure the disease or satisfy every patient. Still, neural procedures are better than non-neural procedures when restoring the smile.

Direct nerve coaptation or indirect nerve coaptation with nerve graft offers the best opportunity to restore mimetic facial expression, including smiling. Timing is very important. Repair performed primarily as soon as possible after a cutting injury, usually no later than three weeks, gives the patient a good smiling appearance. Secondary nerve grafts are still acceptable. If the transected area is at the terminal branches beyond the division of the temporofacial and cervicofacial trunks, the final result is often excellent or good. However, if the lesion is in the area of trunk division, two cable grafts seem better than one single graft with two terminal branches. If the lesion is proximal to the trunk division, realignment of both cut ends according to the topographical study by Meissl is difficult, but facial group repair is feasible and possible [18].

Microsurgery of the facial nerve in the temporal bone for decompression or tumor resection with restoration by nerve graft has provided good results. It is frequently used in Bell's palsy and fractures of the petrous part of temporal bone. Timing and indications are the determining factors [11, 17].

A cross-face nerve graft is used when the proximal segment is not available and the injury is recent, usually less than one year. Synchronous action is a theoretical advantage, but the inconsistent result makes surgeons hesitant to use it, especially in palsies of longer than six months duration.

Hypoglossal facial nerve transfer is still a simple and popular procedure. However, for the restoration of the smile it is not the optimal procedure because of asynchronous expression. However, it is more satisfactory in the aged patients. Relaxed skin of older patients can cover the disadvantage of mass movement and asynchronous expression.

Microneurovascular free muscle transfer with cross-face nerve graft or ipsilateral facial nerve (with or without nerve graft) in long-standing cases is presently a well-developed technique that can achieve good function with impressive results, although it is rather complicated. It is now accepted by many plastic surgeons. The surgical technique is no longer a major difficulty, and patients can attain a synchronous natural smile. The main problem is the selection of an ideal muscle, one that is neither too large nor too small. The gracilis and pectoralis minor are now frequently used as the donor muscles.

Terzis [27] showed excellent results using "mini muscles" for facial reanimation such as a strip of the frontalis muscle for forehead wrinkling (a cross-face nerve graft neurotizes the transferred frontalis muscle), platysma for eyelid closure (also cross-face nerve graft–neurotized), and digastric muscle or omohyoid muscle for depression of the lower lip.

Plication or shortening of zygomatic major and other mimetic muscles, wedge resection of the lower lip, and myectomy of intact lower lip are non-neural operative procedures described in detail by Rubin. They effectively improve incomplete facial paralysis, including the appearance of the smile.

Conclusion

For "smile" reconstruction in facial paralysis, in acute nerve disruption direct nerve repair provides the most optimal results. In subacute cases, indirect repair with nerve graft also gives a good result. In chronic cases, partial paralysis, plication, and myectomy work well. In chronic complete paralysis, a difficult problem, free functioning muscle transfer with cross-face nerve graft or ipsilateral nerve graft provides a good solution. Other methods such as hypoglossal facial transfer, temporalis muscle transfer, and cross-face nerve graft still have their rather limited and unpredictable results.

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