Acta Neurochir (Wien) (2007) 149: 1205–1210
DOI 10.1007/s00701-007-1412-x
Printed in The Netherlands

Acta Neurochirurgica

Clinical Article

Surgical results of the Hypoglossal-Facial nerve Jump Graft technique

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Received 18 January 2007; Accepted 24 April 2007; Published online 5 November 2007

Summary

Background. The Hypoglossal-Facial nerve crossover has appeared as a surgical option for those scenarios where the facial nerve is injured in its intracranial course, but the conventional technique unequivocally leads to twelfth cranial nerve deficit. In recent years a number of different surgical approaches have been introduced with a view to avoiding the complete section of the hypoglossal nerve, such as the Jump Graft technique. This paper aims to present the results of the Hypoglossal-Facial nerve Jump Graft technique in relation to facial musculature reanimation capability and hemitongue function preservation.

Methods. A retrospective analysis of the records of eight patients submitted to Hypoglossal-Facial nerve Jump Graft technique was performed. The surgical approach was characterised by the interposition of a short graft sutured to the distal stump of the transected facial nerve and sutured end-to-side to the hypoglossi, with cutting of only a third of the diameter of the latter.

Findings. The facial nerve injuries were secondary to temporal bone trauma in five cases and to cerebellopontine angle tumour surgery in three. Grafts were harvested from the greater auricular nerve in six patients and from the sural nerve in two. The results of facial reanimation demonstrated facial symmetry and improvement in the facial tone in all cases, and classified as House-Brackmann grade IV in three (37.5%) and grade III in five (62.5%) patients. There was no incidence of definitive hemitongue atrophy and no patient complaint of swallowing or speech difficulty.

Conclusions. The modification of the conventional technique of Hypoglossal-Facial nerve anastomosis by means of sectioning one third of the hypoglossal nerve area does not lead to dysfunction of this nerve and the surgical results in terms of facial reanimation are satisfactory.

Keywords: Hypoglossal-Facial anastomosis; nerve graft; cranial nerve surgery; temporal bone trauma.

Introduction

The hypoglossal nerve has been classically used in the salvaging of facial paralysis when there was injury to the facial nerve in its intracranial course. A variety of ways of transferring and suturing the hypoglossal nerve to the distal segment of the facial nerve have been described [1, 5, 6, 9, 18]. The most frequent technique used in clinical practice is the direct suture of the proximal stump of the twelfth nerve to the distal stump of the facial nerve, in its extracranial course. While this procedure has proved its reliability, the consequences – such as hemitongue atrophy or synkinesis – have motivated a search for a more acceptable solution to the facial paralysis issue [6, 21].

There are reports about the use of the hypoglossal nerve without creating a loss of function of the ipsilater-

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al hemitongue. These studies included the section of only a portion of the XII cranial nerve diameter [1, 9, 13] – such as one third or one half of the nerve – or pure end-to-side suture [11]. There are also two ways to connect the facial to the hypoglossal nerve (1): direct suture – after drilling the mastoid process and mobilizing the descending portion of the facial nerve to the level of its external genu [5, 18]; or (2) using an interpositional graft between the nerves, a technique called a Jump Graft [9, 14].

The aim of this paper is to present the results of the Hypoglossal-Facial nerve Jump Graft technique in order to determine its potential for reanimation of the facial musculature and preservation of tongue function.

Clinical materials and methods

A retrospective analysis of the records of all patients who were submitted to Hypoglossal-Facial nerve Jump Graft technique for treatment of complete unilateral facial palsy, operated by the author during the years of 2004 and 2005 was performed. Informed consent was obtained from all participants and the study was carried

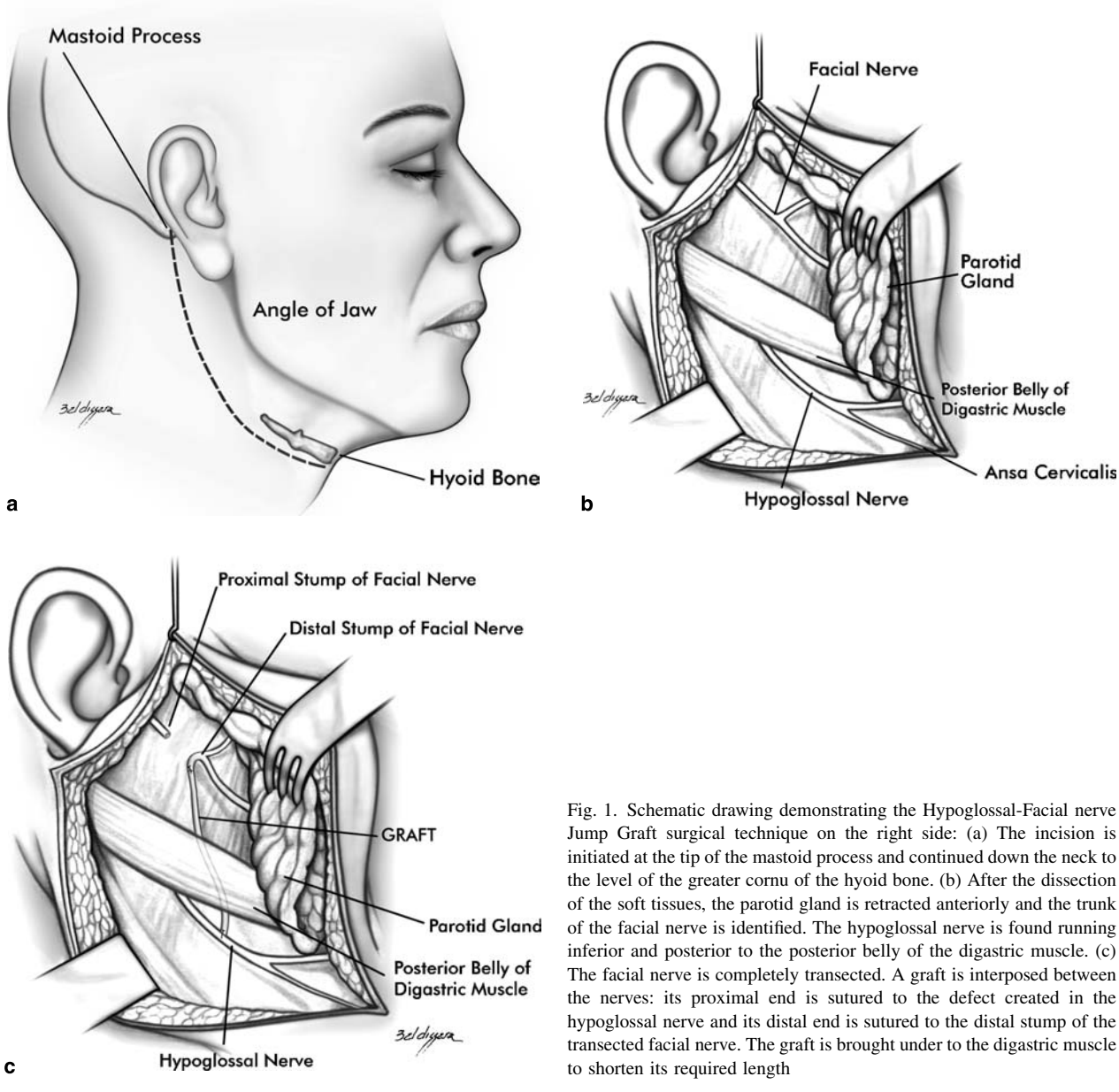

Fig. 1. Schematic drawing demonstrating the Hypoglossal-Facial nerve Jump Graft surgical technique on the right side: (a) The incision is initiated at the tip of the mastoid process and continued down the neck to the level of the greater cornu of the hyoid bone. (b) After the dissection of the soft tissues, the parotid gland is retracted anteriorly and the trunk of the facial nerve is identified. The hypoglossal nerve is found running inferior and posterior to the posterior belly of the digastric muscle. (c) The facial nerve is completely transected. A graft is interposed between the nerves: its proximal end is sutured to the defect created in the hypoglossal nerve and its distal end is sutured to the distal stump of the transected facial nerve. The graft is brought under to the digastric muscle to shorten its required length

out in accordance with the Declaration of Helsinki II. The postoperative results were assessed as to tongue function and facial reanimation. Facial nerve functionality was judged using the House-Brackmann grading system [10]. The preoperative diagnostic investigations included electrophysiological studies of the facial nerve and, in those patients with a skull base fracture, a computed tomography of the temporal bone. The patients were followed-up for 6–12 months in order to determine spontaneous clinical or electrophysiological signs of facial re-innervation in those secondary to temporal bone trauma or when the surgical description did not confirm nerve injury. If a complete facial nerve section was identified during cerebellopontine angle surgery, the hypoglossal-facial nerve crossover was performed without delay.

Surgical technique (Fig. 1)

The incision was made from the tip of the mastoid process and continued down to the neck, to the level of the greater cornu of the hyoid bone. Subcutaneous tissue was carefully dissected, in order to preserve the greater auricular nerve. This nerve was isolated and five to eight centimeters were removed to be used as graft between the facial and the hypoglossal nerves. In those cases in which the nerve was considered too thin, the ipsilateral sural nerve was used as graft. The facial nerve trunk was isolated in the posterior border of the parotid, next to the stylomastoid foramen. The hypoglossal nerve was identified in the neck, posterior to the digastric muscle, between the internal jugular vein and the internal carotid artery [20]. Under microscopic magnification, the hypoglossal nerve was partially transected at one third of its diameter, one centimeter proximal to the point of take-off of the *ansa cervicalis*. The facial nerve was completely transected. The proximal end of the graft was sutured to the proximal end of the defect created in the twelfth nerve, and the distal end of the graft sutured to the distal stump of the transected facial nerve, using 10.0 suture and fibrin glue. The graft was brought under the digastric muscle, in order to shorten its length. The playsma and skin were closed in two layers. Post-operative cervical immobilisation was not recommended in any patient.

Results

During the period of the study there were eight consecutive patients who underwent Hypoglossal-Facial nerve Jump Graft technique, presenting clinically as a complete unilateral facial palsy (House-Brackmann grade VI). There were seven males and only one female. The palsy was secondary to temporal bone trauma in five (lesion of the facial nerve on its intratemporal segment) and resulting from its injury during surgery of cerebellopontine angle tumours in the other three patients. Time between injury and the crossover surgery ranged from 1 to 13 months and the follow-up period was 15 months in one patient, 18 months in five and 24 months in two cases. The details of each patient are presented in Table 1.

The greater auricular nerve was chosen as the first option for grafting, and used in six patients. This nerve has potential advantages as a graft, because it is located in the same operative field, excluding a second incision,

Table 1. *Characteristics of eight patients submitted to Hypoglossal-Facial Jump Graft technique to treat hemifacial paralysis*

Pt no up	Age	Gender	Source	Graft (mm)	Result (HB†) grade	Tongue deficit	Time	
							Delay*	Follow-up (months)
1	23	M	skull base fracture	GAN‡ 70	IV	no	11	18
2	41	M	acoustic neuroma surgery	GAN 70	III	no	3	15
3	45	M	skull base fracture	sural 60	III	no	6	18
4	37	M	skull base fracture	sural 80	IV	transient	13	18
5	54	M	CPA‼ meningioma surgery	GAN 60	III	no	5	24
6	30	F	skull base fracture	GAN 90	IV	no	10	18
7	33	M	acoustic neuroma surgery	GAN 70	III	no	1	24
8	46	M	skull base fracture	GAN 70	III	no	7	18

* Time between injury and XII–VII crossover.
† House-Brackmann grading system.
‡ *GAN* Greater auricular nerve.
‼ *CPA* Cerebellopontine angle.

and its size usually matched that of the proximal end of the hypoglossal nerve defect and the distal stump of the transected facial nerve [17]. In two patients, the greater auricular nerve presented a very small diameter, and the sural nerve was harvested as a graft to bridge the gap. In one patient, the facial nerve was bifurcating as soon as it exited the stylomastoid foramen, and it was not possible to find an extracranial facial nerve trunk. In this patient, the hypoglossal nerve was divided at one half of its diameter and a double cable of graft was sutured to each facial branch. The length of the graft ranged from 60 to 90 mm.

The results of the surgical technique for reanimation capability demonstrated facial symmetry and improvement of the facial tone in all patients. They were graded as House-Brackmann grade IV (moderately severe dysfunction, obvious weakness, normal symmetry and tone at rest, incomplete closure of the eye) in three patients (37.5%) and grade III (moderate dysfunction, no disfiguring difference between both sides, normal symmetry and tone at rest, complete eye closure with effort) in five cases (62.5%). Voluntary movements usually began at nine to twelve months after the surgery, and it was always related to forced movements of the tongue. No spontaneous reflexive facial function or emotional expression was observed. On the other hand, there was no instance of excessive facial tone, hyperactivity and/or facial hemispasm. No patient presented synkinesis or mass movement of the facial musculature.

There was no evidence of definitive hemitongue atrophy in this group, and no patient complaint of difficulty in swallowing or speech. A single patient – in whom it was necessary to cut half of the fibers of the hypoglossal nerve – developed postoperative transient difficulty with speech, and returned to normal function about five months after the surgical procedure.

Discussion

The idea of sacrificing of the XII cranial nerve to restore facial function became the basic principle of the facial musculature reanimation in those patients in which the proximal stump of the facial nerve is unavailable [19]. This situation is most frequently seen following surgery to resect tumours in the cerebellopontine angle or following radical dissections of the cranial base. Improvements in surgical technique and transoperative electrophysiological monitoring, especially in excision of acoustic neuroma, have made the preservation of function of the VII cranial nerve an increasingly likely scenario, and in turn the indication of Hypoglossal-Facial nerve anastomosis an increasingly less probable procedure [2, 4]. On the other hand, the increase of incidence of head injury in the civilian population has triggered a higher incidence of facial nerve injury secondary to complex temporal bone trauma [16]. Our data is in accordance with this premise and skull base trauma was the cause of the facial paralysis in more than half of the patients.

The conventional technique – direct suture of the distal stump of the hypoglossi to the facial nerve – provides good results (House-Brackmann grade III or better) in terms of muscle reanimation in 55–66% of the cases, but it also results in ipsilateral hemitongue paralysis [6]. The technique of suture to the lateral aspect of the hypoglossal nerve was developed as an alternative to avoid this kind of residual defict [13]. Different techniques are currently in use, including the use of an interpositional graft, in association with cutting one third or one half of the XII cranial nerve. The results of these techniques are quite similar to conventional surgery in terms of facial rehabilitation. Malik *et al.* [12] observed 56% of good results in patients who underwent cable nerve interposition; Hammerschlang [9] reported 83.3% of House-Brackmann grade III or better results in patients submitted to the same technique; and Guntinas-Lichius *et al.* [8] did not observe a significant difference of outcome in patients submitted to conventional or to modified Hypoglossal-Facial nerve transfer techniques. Our results (62.5% of House-Brackmann grade III) are in concordance with the literature. The best results were observed when the surgery was not delayed and the cable of graft was shorter. Fair outcomes in terms of facial reanimation were observed when the graft length was larger than 70 mm and the time delay to surgery was longer than ten months. The type of graft used, great auricular or sural nerve, did not compromise the final prognosis.

Motor consequences associated with aberrant reinnervation are commonly observed after a classical Hypoglossal-Facial anastomosis. Eighty per cent of patients display facial muscle synkinesis and mass movement; and 15–20% develop excessive facial tone, hyperactivity or facial spasm [6, 16, 22]. The use of just one third of the hypoglossal nerve area as source for the neurotization has the theoretical potential to reduce these kinds of complications [9, 11, 13]. In the present series, it was observed that the most important result of the surgery was the recovery of the facial tone and symmetry, associated with some volitional facial movements. On the other hand, there were no ‘‘over-innerva-

tion'' complications in our patients. The Jump Graft technique provided a facial reanimation that was not as invasive as the classical procedure, and the use of an interpositional graft may be the reason for this difference. The growing axons from the XII cranial nerve have to cross two suture lines to reach the facial musculature, and the distance between the hypoglossal and the facial nerve is greater than the conventional method. The number of axons that reach the facial musculature is consequently lower than that of the conventional procedure. Thus, despite the fact that this technique offers a lower level of trigger power to activation of voluntary facial movements, the reduced incidence of some side-effects related to the aberrant re-innervation, most of them catastrophic for the life quality of these patients, increases the acceptability of the surgical results for the patient. Otherwise, the direct suture of the distal stump of the facial nerve – after its intratemporal transposition – to the lateral aspect of the XII cranial nerve has the potential to be a more powerful source of axons to trigger the voluntary facial musculature [5]. However, this surgical approach (first described by Sawamura and Abe [18]) has demonstrated results which do not differ from those of the interpositional graft surgery. In a series of five patients, Rebol *et al.* [15] reported only two that attained results as good as House-Brackmann grade III, and in a retrospective study including 15 patients with a minimum follow-up of 18 months, Franco-Vidal *et al.* [7] reported 73% of good results (House-Brackmann III or better).

The complete section of the hypoglossi, as it is regularly done in the classical procedure, unequivocally leads to some tongue dysfunction and atrophy [1, 5, 6, 8]. The residual deficits are usually swallowing difficulty and speech articulation disability, as observed in 74% of the patients [6, 14, 22]. The section of one third of the XII cranial nerve can avoid these sequelae, as observed in our series: no patients developed definitive atrophy or related motor lingual deficits. The technique probably leaves a sufficient number of axons to maintain a pattern of minimal normal innervation to the affected hemitongue. Based on previously reported data [12], there is no difference between sectioning one half or one third of the hypoglossal nerve diameter in terms of facial reanimation, but the risk of damage to the nerve is higher in the former. This situation was observed in the patient number 4, in whom it was necessary to cut half of the diameter of the nerve to suture two cables of graft, resulting in a transient tongue deficit.

Conclusions

The modification of the conventional technique for Hypoglossal-Facial nerve anastomosis by means of sectioning only one third of the hypoglossal nerve area does not lead to dysfunction of this nerve, and the surgical results in terms of facial reanimation are satisfactory. The Jump Graft technique constitutes a reliable alternative approach to patients with facial paralysis who do not wish to face their tongue function being compromised due to the surgical procedure.

References

1. Arai H, Sato K, Yanai A (1995) Hemihypoglossal-facial nerve anastomosis in treating unilateral facial palsy after acoustic neurinoma resection. J Neurosurg 82: 51–54
2. Asaoka K, Sawamura Y, Nagashima M, Fukushima T (1999) Surgical anatomy for direct hypoglossal-facial nerve side-to-end ''anastomosis''. J Neurosurg 91: 268–275
3. Bernat I, Vitte E, Lamas G, Soudant J, Willer JC, Tankere F (2006) Related timing for peripheral and central plasticity in hypoglossal-facial nerve anastomosis. Muscle Nerve 33: 334–341
4. Donzelli R, Maiuri F, Peca C, Cavallo LM, Motta G, de Divitiis E (2005) Microsurgical repair of the facial nerve. Zentralbl Neurochir 66: 63–69
5. Farraresi S, Garozzo D, Migliorini V, Buffatti P (2006) End-to-side intrapetrous hypoglossal-facial anastomosis for reanimation of the face. Technical note. J Neurosurg 104: 457–460
6. Fernandes E, Pallini R, Palma P, Lauretti L (1997) Hypoglossal-facial nerve anastomosis. J Neurosurg 87: 649–650
7. Franco-Vidal V, Blanchet HLiguoro D, Darrouzet V (2006) Side-to-end hypoglossal-facial nerve anastomosis with intratemporal facial nerve translocation. Long-term results and indications in 15 cases over 10 years. Rev Laryngol Otol Rhinol 127: 97–102
8. Guntinas-Lichius O, Streppel M, Stennert E (2006) Postoperative functional evaluation of different reanimation techniques for facial nerve repair. Am J Surg 191: 61–67
9. Hammerschlag PE (1999) Facial reanimation with jump interpositional graft hypoglossal facial anastomosis and hypoglossal facial anastomosis: evolution in management of facial paralysis. Laryngoscope 109: 1–23
10. House JW, Brackmann DE (1985) Facial nerve grading system. Otolaryngol Head Neck Surg 93: 146–147
11. Koh KS, Kim JK, Kim CJ, Kwun BD, Kim SY (2002) Hypoglossal-facial crossover in facial nerve palsy: pure end-to-side anastomosis technique. Br J Plast Surg 55: 25–31
12. Malik TH, Kelly G, Ahmed A, Saeed SR, Ramsden RT (2005) A comparation of surgical techniques used in dynamic reanimation of the paralyzed face. Otol Neurotol 26: 284–291
13. Manni JJ, Beurskens CH, van de Velde C, Stokroos RJ (2001) Reanimation of the paralyzed face by indirect hypoglossal-facial nerve anastomosis. Am J Surg 182: 268–273
14. May M (2000) Nerve substitution techniques: XII–VII Hook-up, XII–VII Jump Graft and Cross-Face Graft. In: Schaitken BM, May M (eds) The facial nerve: May's 2 edn. Thieme Medical Pub, New York, pp 611–635
15. Rebol J, Milojkovic V, Didanovic V (2006) Side-to-end hypoglossal-facial anastomosis via transposition of the intratemporal facial nerve. Acta Neurochir (Wien) 148: 653–657

16. Rosenwasser RH, Liebman E, Jimenez DF, Buchheit WA, Andrews DW (1991) Facial reanimation after facial nerve injury. Neurosurgery 29: 568–574
17. Salame K, Ouaknine GE, Arensburg B, Rochkind S (2002) Microsurgical anatomy of the facial nerve trunk. Clin Anat 15: 93–99
18. Sawamura Y, Abe H (1997) Hypoglossal-facial nerve side-to-end anastomosis for preservation of hypoglossal function: results of delayed treatment with a new technique. J Neurosurg 86: 203–206
19. Streppel M, Heiser T, Stennert T (2000) Historical development of facial nerve surgery with special reference to hypoglossal-facial nerve anastomosis. HNO 48: 801–808 (Ger)
20. Vacher C, Dauge MC (2004) Morphometric study of the cervical course of the hypoglossal nerve and its application to hypoglossal facial anastomosis. Surg Radiol Anat 26: 86–90
21. Tatagiba M, Matthies C, Sammi M (1994) Facial nerve reconstruction in neurofibromatosis. Acta Neurochir (Wien) 126: 72–75
22. Tatagiba M, Marques E, Sammi M (2003) Anastomose hipoglosso facial. In: Tatagiba M, Mazzer N, Aguiar PHP, Pereira CU (eds) Nervos Periféricos. Rio de Janeiro Ed. Revinter, pp 131–134

Comment

In 1991, May *et al.* described the so-called "jump interpositional graft anastomosis" between the hypoglossal nerve and the facial nerve, for facial reanimation, without tongue atrophy [1]. In this paper the author presents his experience with this technique in 8 cases, with good results (House-Brackman: Grade IV – 3 cases and Grade III – 5 cases).

Because of the importance of a normal tongue function in mastication, swallowing and speaking, an hemiglossal atrophy can be quite disturbing. In this method the hypoglossal function is preserved, what is an advantage when comparing with the classical XII-VII anastomosis technique. But, as the author himself said, probably the direct suture of the distal stump of the facial nerve (after drilling the mastoid and mobilizing it from its intrapetrous course) to the lateral aspect of the XII nerve can avoid the use of interpositional graft, and has the potential to be a more powerful source of axons.

Our experience is in entire agreement with this last sentence. We treated 10 patients with the Sawamura-Abe technique [2] (unpublished data) and most of our patients (70%) achieved Grades III and II (House-Brackman Scale). We believe that the difference in the results is related to the use of grafts (60 to 90 milimiters) by the author. A second suture line certainly increases the possibility of block or misrouting of the axons in regeneration.

Besides the different opinions about the best surgical way to treat those patients, we agree that the complete section of the hypoglossal nerve should be avoided.

The author should be congratulated for this nice contribution to nerve literature.

References

1. May M, Sobol SM, Mester SJ (1991) Hypoglossal-facial nerve interpositional jump graft for facial reanimation without tongue atrophy. Otolaryngol Head Neck Surg 104: 818–825
2. Sawamura Y, Abe H (1997) Hypoglossal-facial nerve side-to-end anastomosis for preservation of hypoglossal function: results of delayed treatment with a new technique. J Neurosurg 86: 203–206

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