Unmasking of the trigemino-accessory reflex in accessory facial anastomosis

Angel Esteban, Julio Prieto

Abstract

Objective—To evaluate the possible blink reflex responses in facial muscles reinnervated by the accessory nerve.

Method—Eleven patients with a complete facial palsy were submitted to a surgical repair by an accessory facial nerve anastomosis (AFA). In this pathological group, blink reflex was studied by means of percutaneous electrical stimulation of the supraorbital nerve and recording from the orbicularis oculi muscle. A control group comprised seven normal people and seven patients with a complete Bell's facial palsy; in this group, responses on the sternocleidomastoideus (SCM) muscles were studied after supraorbital nerve stimulation.

Results—All the patients with AFA showed a consistent degree of facial reinnervation. Ten out of the 11 patients with AFA showed reflex responses; in six, responses were configured by a double component pattern, resembling the R1 and R2 components of the blink reflex; three patients had an R1-like response and one patient showed a unique R2 component. Mean values of latencies were 15.2 (SD 4.6) ms for the R1 and 85.3 (SD 9.6) ms for the R2. In the control group, eight out of 14 people had evidence of reflex responses in the SCM muscles; these were almost exclusively configured by a bilateral late component (mean latency 63.5 (SD 15.9) ms) and only one of the subjects showed an early response at 11 ms.

Conclusion—The trigemino-accessory reflex response in the pathological group was more complex and of a significantly higher incidence than in the control group. These differences could be tentatively explained by a mechanism of synaptic plasticity induced by the impairment of the efferent portion of the reflex. This could unmask the central linking between the trigeminal and the accessory limbs of the reflex. The findings described could be a demonstration of neurobiogenic function in the repairing process of the nervous system.

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Keywords: blink reflex; trigemino-accessory reflex; accessory facial nerve anastomosis; neuroplasticity

The evaluation of the trigeminofacial reflexes is a common exploration in neurological clinical practice. Electrophysiologically, the blink reflex is often used to test the brainstem. The meth-

odology to obtain this reflex and the evaluation of its parameters are well established. Other trigeminal reflexes using rather different motor pathways than the blink reflex are much less known and employed. This is the case for the trigeminoaccessory or trigeminocervical reflex, first described in animals¹ and later in humans.²

Table 1 Pathological group; complete facial palsy with subsequent accessory-facial anastomosis. Clinical data

Patient	Sex	Side	Age (y)	Evolution*	Degree of reinnervation†
1	F	R	59	25	3
2	F	R	53	103	4
3	F	R	66	6	2
4	F	L	23	8	3
5	F	L	36	33	3
6	F	R	42	16	3
7	F	R	35	7	2
8	M	R	57	24	2
9	M	L	55	5	2
10	F	R	39	42	3
11	F	L	67	30	4

*Time since the accessory-facial anastomosis (in months).

†Arbitrary scale from 0=none to 4=maximal.

Table 2 Control group; seven normal subjects and seven patients with complete facial palsy. Clinical data and trigeminoaccessory reflex responses

Subject	Facial palsy	Age (y)	Reflex responses*	
			Right trigeminal stimulation	Left trigeminal stimulation
1	No	54	R2 i, c	R2 i, c
2	No	48	R2 i, c	NE
3	No	35	R2 i, c	R2 i, c
4	No	32	No	NE
5	No	44	R2 i, c	R2 i, c
6	No	42	No	No
7	No	45	No	No
8	L	71	R2 i, c	R2 i, c
9	L	74	NE	R1; R2 i, c
10	L	63	No	No
11	R	46	No	No
12	R	56	R2 i, c	R2 i, c
13	R	62	No	No
14	R	62	R2 i, c	R2 i, c

*Recorded on the sternocleidomastoideus muscles.

i=Ipsilateral; c=contralateral; NE=non-explored; R=right; L=left.

Table 3 Pathological group. Reflex responses obtained on the facial muscles of the accessory-facial anastomosis side

Patient	Supraorbital trigeminal stimulation	
	Pathological side	Normal side
1	R1; R2	NE
2	R1	NE
3	No	No
4	R1; R2	R2
5	R1; R2	R2
6	R1; R2	R2
7*	R1; R2	No
8	R1; R2	R2
9	R2	R2
10	R1	R2
11	R1	No

(*) Responses obtained only on the orbicularis oris muscle.

Department of Clinical Neurophysiology, Hospital General Universitario Gregorio Marañón, C/ Dr Esquerdo 46, 28007 Madrid, Spain
A Esteban

Department of Morphological Sciences and Physiology, Universidad Europea, C/ Tajo s/n, Villaviciosa de Odón, 28670 Madrid, Spain
J Prieto

Correspondence to: Dr A Esteban, Department of Clinical Neurophysiology, Hospital General Gregorio Marañón, C/ Dr Esquerdo 46, 28007 Madrid, Spain.

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Figure 1 Patient 6. Right accessory-facial anastomosis. Simultaneous recording in right (R) orbicularis oculi (OO) and orbicularis oris (OOr) muscles. A double response (R1 and R2) is obtained with the ipsilateral supraorbital nerve stimulation whereas the contralateral stimulation induces a single R2 response in both muscles.

In clearly established lesions of the CNS, adaptative mechanisms and functional reorganisation phenomena can promote the development of substitutive motor activities in response to the requirements of the external environment.³

In this study, we have evaluated the presence of an unusual blink reflex in a group of patients with a complete anatomical lesion of the facial nerve in which the normal efferent pathway was surgically replaced by means of an accessory-facial anastomosis. The aim of the study was the evaluation of the incidence and configuration of the trigemino-accessory reflex in its normal cervical areas of expression as well as the variations that this reflex may present after the lesion and subsequent recovery of its peripheral motor limb.

Patients and methods

PATIENTS

Eleven patients (two men and nine women) formed the pathological group with a mean age

of 48.3 years (range 23 to 67 years) that had a complete facial palsy after surgery for acoustic neuroma (10 patients) or cholesteatoma (patient 9). All patients had undergone an accessory-facial anastomosis; the mean evolution time between surgery and the first electrophysiological evaluation was 27.2 (SD 28) months (range 5 to 103 months). The palsy side was right in seven and left in four patients (table 1).

Seven normal subjects (four women and three men) and seven patients with complete unilateral Bell's palsy (two women and five men) electrophysiologically confirmed formed the control group. Their mean age was 52.4 (SD 12.8) years (range 32 to 74 years, table 2).

METHODS

In the 11 patients with complete facial nerve palsy and accessory-facial anastomosis, we evaluated the degree of reinnervation with an arbitrary scale from 0 to 4 for the EMG activity obtained in maximal contraction. The

Figure 2 Patient 2. Right accessory-facial anastomosis. A single early response (R1) is obtained in the orbicularis oculi (OO) and the orbicularis oris (OOr) muscles of the pathological side with the ipsilateral supraorbital nerve stimulation (right). No response is provoked with the left stimulation. Normal blink reflex responses in the left orbicularis oculi (LOO).

Table 4 Values of trigeminoaccessory responses obtained within the pathological and control groups (mean (SD); in ms)

Group	No. Sides	M*	Reflex responses †		
			R1	R2i	R2c
Pathological‡	11	6.4 (3.2) (n=11)	15.2 (4.6) (n=8)	85.3 (9.6) (n=6)	—
Control§	25	—	11 (n=1)	63.5 (15.9) (n=14)	74.1 (16.6) (n=14)

*Pretragal facial nerve stimulation.

†Supraorbital nerve stimulation.

‡Recorded on facial muscles.

§Recorded on sternocleidomastoideus muscles.

i=Ipsilateral; c=contralateral.

recording was made with concentric needle electrodes in the frontalis (F), orbicularis oculi (OO) and orbicularis oris (OOr) muscles of the affected side. Eight patients were re-evaluated several times.

The blink reflex was studied from both sides with electrical stimulation of the supraorbital nerve on the supraorbital notch. We used the minimum electrical shock to obtain stationary responses; intensity usually ranged from 15 and 25 mA but in some cases higher intensities were needed and in one patient no response was obtained despite the strength of the stimulus being raised as high as 65 mA. All patients received supramaximal stimuli in the facial nerve on pretragus. Recordings were obtained simultaneously in both OO and OOr muscles of the affected side, and in two patients the F muscles were also tested.

To evaluate the trigeminoaccessory reflex of the control group we used the same stimulation technique and the recording was carried out with concentric needle electrodes bilaterally in the midpart of the sternocleidomastoideus (SCM) muscles. In most cases both sides were evaluated with a total of 25 sides tested in 14 people.

In the pathological group, the compound motor action potential (MAP) in OO muscle was evaluated after facial nerve stimulation. The reflex responses obtained after trigeminal stimuli within the OO muscles (pathological group) and the SCM muscles (control group) were analysed. For latency, the components of responses were called R1 (early) and R2 (late).

STATISTICAL EVALUATION

Latency of the R2 response in the two subgroups of the control group was compared

Figure 3 Linear correlation between M potential latency and early reflex component (R1) in patients with accessory-facial anastomosis ($R=0.924$; $p<0.05$).

using Student's t test. The incidence of the reflex response in these two subgroups was compared with a χ^2 test, as was the incidence of the reflex response in the control group compared with those of the pathological group. The relation between the latency of MAP and the latency of R1 in the pathological group was tested with a linear regression.

Results

The degree of reinnervation obtained in the facial muscles after an accessory-facial anastomosis in the 11 patients of the pathological group is shown in table 1. Two patients showed a maximal score, five an important degree of reinnervation, and the other four a moderate one. The degree of reinnervation did not show a systematic correlation with the time of evolution. The stimulation of the supraorbital nerve ipsilateral to the lesion evoked a response in the facial muscles (innervated by the accessory nerve) in 10 out of the 11 patients (90.9%), 16 sides of the 20 evaluated (table 3). Six patients (1, 4, 5, 6, 7, and 8) showed a response formed by an early component (probably R1) and a late component resembling R2 (fig 1). In patients 1, 2, 6, 9, 10, and 11 responses could also be obtained in other facial muscles different from OO (F and OOr muscles) and in one patient (7) they were obtained only in the OOr muscle. In three patients (2, 10, and 11) the response contained only an early R1 component (fig 2) and in patient 9 only a late R2 component was present. The contralateral stimulation provoked R2 responses on the pathological side in six out of the nine patients evaluated (table 3). The mean value (SD) of latencies of the R1 and R2 responses recorded in the OO were 15.2 (4.6) ms and 85.3 (9.6) ms. The latency of direct response—which was obtained in all patients—showed a mean value of 6.4 (3.2) ms (table 4). A significant Pearson positive correlation ($R=0.924$, $p<0.05$) was shown between latency and the R1 reflex component latency (fig 3).

The homogeneity of the control group, formed by a subgroup of normal people and another subgroup of patients with complete facial palsy, was tested comparing the incidence of the responses with a χ^2 test and the value of R2 latency obtained in each subgroup with the Student's t test; there were no significant differences. In this group the incidence of reflex responses in the SCM muscles with supraorbital nerve stimulation was 57%; they were obtained in eight out of 14 people, 14 sides of the 25 evaluated (table 2). Only patient 9 showed a double response formed by an early ipsilateral and a late bilateral component; seven patients showed only the bilateral late components (patients 1, 2, 3, 5, 8, 12, and 14, fig 4), and in the other six patients (4, 6, 7, 10, 11, and 13) there was no response. The mean latency value of R2 ipsilateral to the stimulus was 63.5 (SD 15.9) ms ($n=14$) and 74.1 (SD 16.6) ms ($n=14$) for the contralateral side (table 4).

The difference in incidence of the reflex response between the pathological and the control groups was significant ($p<0.05$).

Figure 4 Control patient 12. Right Bell's facial palsy. Simultaneous recording in the sternocleidomastoideus (SCM) muscles by means of concentric needle electrodes. Supraorbital nerve stimulation provokes bilateral late reflex responses; the complete right facial palsy ruled out the possibility of a diffuse response from the platysma muscle in this side.

Discussion

The evoked responses that were obtained with the electrical stimulation of the supraorbital nerve in SCM muscles of the control group and in the reinnervated facial muscles of the pathological group must be considered reflex responses driven throughout a trigemino-accessory pathway. This situation is only possible if a central connection exists between the afferent trigeminal limb and the spinal nuclei of the 11th cranial nerve.

Experimental data exist that show activation of the motor neurons of the first cervical segments on trigeminal nerve stimulation.^{4,5} In humans, reflex responses have also been found in cervical muscles after stimulation of trigeminal branches.^{2-6,8} Sartucci *et al* found cervical responses recorded within the SCM and trapezius muscles in all 21 normal people tested with an electrical stimulation from each of the trigeminal branches. Responses were always bilateral, with a unique component in each side and their mean latency was 48.7 (SD 8.1) ms. They eventually proposed this reflex as a new method to evaluate lesions in the medulla and upper spinal cord segments.⁷ These data show important differences in the latency as well as the incidence of the responses in comparison with our own. The discrepancies might be partly accounted for by the different recording methods used; surface electrodes employed by these authors do not accurately permit the differentiation of the SCM activity from that of the overlying platysma colli muscle, a muscle supplied by the facial nerve which could be implicated in the normal trigeminofacial reflex response. In the current study, concentric needle electrodes have been used, which should decrease the possibility of volume conduction from other close muscular territories. Moreover, the presence of a response on the ipsilateral side to the lesion in the subgroup of patients with complete Bell's palsy (fig 4), rules out the possibility of diffusion from neighbouring facial muscles and confirms the accessory nerve as the efferent limb of the reflex.

A trigemino-accessory reflex response was found in 57% of the normal subjects; in the group of patients with accessory-facial anastomosis the incidence of responses was significantly higher and of more complex configuration, with frequent double component similar to the typical blink-reflex response. It is difficult to explain the high incidence of the R1 response in the accessory-facial anastomosis group as opposed to its only occasional presence in the control group. However, given that the plasticity mechanism could control a fine functional target, it could be accepted that a "two component" blink reflex response (six out of 11 in the series) would be more complete and perhaps more "functionally useful" than a "one component" response, whatever the reflex component obtained would be. A mechanism of synaptic plasticity should facilitate the reflex responses. After the abnormal conditions created by the surgical lesion of the accessory nerve, with the subsequent regeneration phenomena and reinnervation of new muscular territories, this pathway could reach a high degree of functional facilitation in relation to the basal state, due to a mechanism of induced neuronal plasticity.⁹⁻¹¹ Plasticity of the nervous system could be due to an unmasking mechanism that turns on some synaptic connections, which were anatomically preformed but functionally inhibited; the inhibition could be mediated by GABA.¹² This mechanism would begin when the dominant system is damaged.¹³ The existence of preformed pathways in the brainstem which remain inhibited in normal conditions has been considered in diseases which alter the excitability of the facial area and the appearance of an unusual contralateral R1 response in the trigeminofacial blink reflex has been described in these situations.¹⁴⁻¹⁶

Anatomically, connections between the nuclei of the Vth, VIIth, and XIIth cranial nerves through the lateral tegmental field have been demonstrated¹⁷; connections between the trigeminal and accessory nerves are less clearly proved but there are some data that support this relation. Cajal¹⁸ described a contingent of

thin fibres coming from the descendent branches of the Vth cranial nerve and going to the area of origin of the spinal portion of the XIth cranial nerve. Other authors have described trigeminal fibres of the spinal tract which reach the posterior horn at the C3⁴ 19 20 or C4 level.²¹ These fibres would probably establish some connections with the motor neurons of the accessory nerve.

Another exteroceptive reflex in SCM muscles after electrical stimulation of the supraorbital nerve has been described in normal subjects.²² This reflex was induced in both SCM muscles during a voluntary contraction of moderate intensity. In these conditions unilateral supraorbital stimulation induced the suppression of the activity between two facilitation periods; the first one was short and inconstant (sometimes absent) and the second one, occurring immediately after the inhibition period, was longer and began around 70 ms after the stimulus. This distribution of responses, their configuration, and their incidence were similar to our results. The systematic existence of the responses in normal people could probably be due to the presence of a basal voluntary activity when the electrical stimuli are delivered; in this situation the facilitation of any reflex response has been seen.²³ The inconsistency of the first period of facilitation, even in these conditions, is similar to the absence of the early response found in our normal group. This fact contrasts with the almost systematic obtention of an R1 response in the pathological group of patients with accessory-facial anastomosis being probably the consequence of a "neurobionomic" process of facilitation. The neurobionomic function defines the mechanisms of an integrated sensory-motor activity that turn on after neuroanatomical lesions according to the demand of the external environment.³

In normal subjects the existence of reflex responses in muscles supplied by the hypoglossal nerve evoked by the trigeminal stimulation is not clearly established (we did not obtain them in the three subjects evaluated). Nevertheless, these responses have been described in a group of patients after a hypoglossal-facial anastomosis performed for the treatment of facial hemispasm and acoustic neuroma.²⁴ The situation could be similar to that of the accessory nerve.

In conclusion, the lesion of the efferent limb of a preformed trigemino-accessory reflex probably facilitates the response by a mechanism of synaptic adaptative plasticity. The reason why the embryo possesses more path-

ways than those which are going to be used in adults is unknown. A safety factor would tend to maintain them—although inhibited—instead of abolishing them when their function during the adult period would have finished.

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