

Magnetic Facial Nerve Stimulation in Bell's Palsy

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The transcranial magnetic stimulation (TMS) technique makes it possible to stimulate the intracranial part of the facial nerve. In a total of 51 patients with acute Bell's palsy, TMS was performed, and the responses were compared with those elicited by conventional extracranial electric stimulation (EES). Clinical recovery was evaluated at 258–539, mean 410, days from the beginning of the palsy. With both techniques the motor evoked potentials (MEPs) could always be elicited on the healthy side, the mean latency being 4.7 ms with TMS and 3.7 ms with EES. In the acute phase, TMS elicited MEPs on the paralyzed side in 47% of the patients, and EES in 98%. The patients with TMS elicitable MEPs during the first 4 days of the palsy had significantly better recovery than those without response ($p < 0.05$). The difference in recovery between patients with or without elicitable TMS responses on days 5–8 and 9–14 was not significant. In EES, the amplitude difference between the two sides within the first 4 days was not significantly ($p > 0.05$) different. On days 9–14 the patients with a $< 80\%$ difference between the two sides recovered significantly ($p < 0.05$) better than those with a difference of $\geq 80\%$. So, TMS may be of help in the early prognosis of Bell's palsy. *Key words: prognostic factors, neurophysiological testing, VII nerve.*

INTRODUCTION

The transcranial magnetic stimulation (TMS) technique provides a noninvasive method for stimulation of the facial nerve intracranially, proximal to its bony canal (1, 2). In Bell's palsy, the site of the lesion is located in the bony canal, distal to the site of TMS impulse generation in the nerve. Therefore, responses to TMS evoked impulses, traversing to the periphery across the site of the injury, might be affected by the nerve lesion immediately, while conventional extracranial electric stimulation (EES) may give impaired responses only after the first few days, secondary to the distal nerve degeneration (3).

To study the usefulness of TMS in the early prognosis of the outcome of Bell's palsy, we examined 51 patients with Bell's palsy with both TMS and EES within the first 14 days from the beginning of motor symptoms, and compared the findings of the two techniques to the degree of clinical recovery from the palsy.

MATERIAL AND METHODS

Subjects

Between 1988 and 1990, altogether 51 consecutive patients, 25 females and 26 males, with unilateral Bell's palsy, diagnosed at the mean age of 50, range 11–78, years, at the Department of Otolaryngology, Tampere University Central Hospital, were available for the study. Twenty-nine of the subjects were considered otherwise healthy, 13 had some cardiovascular disease, 4 pulmonary problems, 4 diabetes, 2 hypothyreosis, 2 allergic problems, and gastrointestinal problems and glaucoma one of each. None of the females was pregnant, but one subject had had a delivery 2 weeks earlier. Twenty-three patients had some prodromal symptoms, mostly sensory feelings in the ear or on the face, before the onset of the palsy.

All patients were examined as soon as they came to the hospital: 15 of them within the first 4 days after the onset of the motor symptoms of the palsy, 21 patients during the next 5–8 days, and the remaining 15 patients 9–14 days after the onset of the palsy. Clinically (background, status, treatment), the patients were similar in these three groups, and the reasons for the different time-intervals before examination were mainly organisational. All subjects were informed about the examination procedure and gave their consent to the study. The study was approved by the local ethics committee.

Clinical examination

Initially and at the late follow-up, 258–539, mean 410, days after the onset of palsy, a clinical ENT examination was performed on all patients, including a precise evaluation of the function of the facial nerve according to the House & Brackmann grading system (4). Also Schirmer's test, electrogustometry and stapedia reflex measurements were performed, and all patients were asked about subjective symptoms of the facial palsy.

Neurophysiological examination

During the neurophysiological examination patients were seated in a sitting position. They were asked to relax and especially to avoid any voluntary contraction of the facial muscles. The relaxation was controlled and confirmed by surface EMG.

Electric stimulation was conducted by the Medelec Mystro MS 20 EMG system. The constant current stimuli were rectangular pulses of 200 μ s in duration. The current intensity was increased up to 40 mA, if necessary. The stimulation was performed bilaterally by delivering an electric impulse at the stylomastoid foramen, the cathode of the stimulating electrode being placed on the skin just anterior to the mastoid process. The anode was situated posteriorly on the mastoid process, 25 mm from the cathode (5).

The proximal facial nerve stimulation was performed transcranially by using a Cadwell MES-10 magnetic stimulator. The capacitor was charged up to 50–70% of its maximum, and discharged into a nearly circular coil with a diameter of 9 cm. The coil was placed tangentially on the head so that the shield of the coil ring was in contact with the scalp surface. The center of the coil ring was 3 cm posterior and 6 cm lateral from the vertex, because this location, according to our experience, discloses the most prominent responses (5). The tip of the coil was always directed anteriorly. A delay of 0.10 ms, probably arising from the triggering of the magnetic stimulation, was subtracted from all measured latencies of magnetically-induced responses.

Motor evoked potentials (MEPs), elicited by TMS or EES, were most distinguishable when recorded at the nasolabial fold (3, 5). An active electrode, 0.5 cm in diameter, was placed on the nasolabial fold, just lateral to nasal ala. The reference electrode was situated laterally on the nose at the level of the nasal bones. Both the TMS and EES responses were recorded during the same examination without removing the electrodes between the different stimuli.

The latency of the muscle response was measured from the beginning of the negative deflection (directing upwards). The amplitude was determined from the start to the peak of the negative deflection.

Statistics

The chi-square test and Student's *t*-test were used to compare the significance of differences.

RESULTS

Both TMS and EES evoked MEPs on the healthy side in every patient (Table I). The amplitudes of the responses did not significantly differ between the two methods ($p > 0.05$).

The latencies of the responses were 4.7 ms (SD 0.49 ms) with TMS and 3.7 ms (SD 0.39 ms) with EES.

Within the first 14 days from the beginning of the palsy, TMS elicited responses on the side of the palsy in 47% ($n=24$) of the patients (Table I). The mean amplitude of the MEPs was 0.4 mV, 2.2 mV less than on the healthy side ($p<0.05$). In the remaining 53% ($n=27$) of the patients, the TMS response was not elicitable. Respectively, with EES the MEPs were elicitable in 98% ($n=50$) of the patients (Table I).

There were altogether five different patterns of responses with EES and TMS. In 2 patients (4%) the amplitudes of MEPs were practically symmetrical, and within the limits of "normal" values with both stimulation methods (Fig. 1A). Ten patients (20%) had elicitable TMS responses, with diminished amplitudes on the paralyzed side, and normal EES responses on both sides (Fig. 1B). Elicitable responses with diminished amplitudes on the paralyzed side were recorded in 12 patients (23%) with both methods (Fig. 1C), and in 26 patients (51%) the paralyzed side showed no TMS responses but still elicitable EES responses (Fig. 1D). In one patient (2%) the MEPs could not be elicited with either method on the paralyzed side.

During the first 4 days after the onset of the disease, 10 out of 15 patients (67%) elicited responses with the TMS on the side of the palsy. The recovery, graded according to the House-Brackmann, was significantly better among those who had an elicitable response ($p<0.05$) (Table II). With EES, the MEPs were always recordable during the first 4 days of palsy, without a significant difference between the means of the amplitudes of the healthy and the paralyzed sides (Table I). In the patients examined for the first time on days 5–8, and on days

Table I. *Amplitudes of the responses elicited with TMS and EES*

HS = healthy side, PS = side of palsy, p = significance of amplitude difference between the healthy and paralyzed sides

	No.	Mean amplitude (mV)	SD	p
<i>EES</i>				
Days 0–14				
HS	51	2.4	1.05	<0.05
PS	51 ^a	1.2	0.91	
Days 0–4				
HS	15	2.0	0.54	>0.05
PS	15	1.5	0.88	
Days 5–8				
HS	21	2.2	1.16	<0.05
PS	21	0.9	0.73	
Days 9–14				
HS	15	3.0	1.04	<0.05
PS	15 ^a	1.3	1.04	
<i>TMS</i>				
Days 0–14				
Total				
HS	51	2.5	1.20	
Response elicitable on the PS				
HS	24	2.6	1.06	<0.05
PS	24	0.4	0.36	

^a One patient did not show a response, its amplitude is counted as 0 mV.

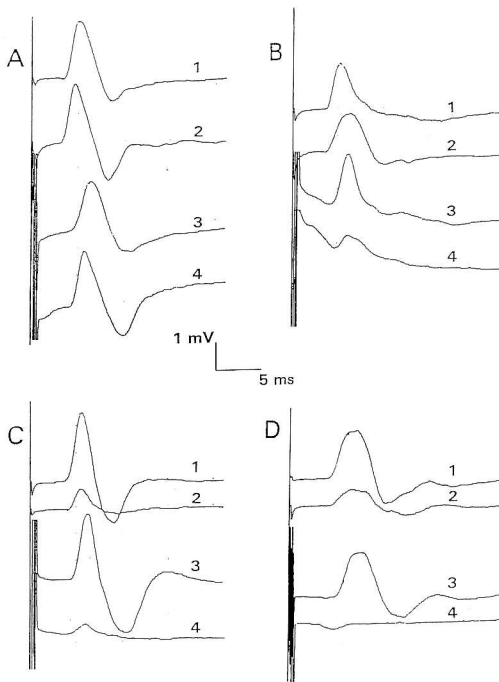


Fig. 1. Types of TMS and EES responses in 4 different patients (A–D). See text for explanations. With each patient, lines 1 and 2 show EES responses on the healthy and paralyzed side, lines 3 and 4 show TMS responses, respectively. In patient B, the TMS response on the paralyzed side (line 4) is preceded by the masseter muscle response (downward deflection). In D, there is no detectable TMS response from muscles innervated by the facial nerve. Only the masseter muscle response appears on the paralyzed side (line 4).

9–14, the respective difference successively increased (Table I), being significant ($p < 0.05$) in both groups.

Within 5–8 days after the onset of palsy, TMS response was found in 8 out of 13 patients (62%). Recovery from the palsy was not significantly different among those who produced a response and those who did not (Table II). With EES, the patients who showed a percentual side-to-side MEP amplitude difference of $< 80\%$ showed a better recovery than those who had an amplitude difference of $\geq 80\%$. This difference, however, was not statistically significant.

Out of the 15 patients who attended the neurophysiological testing 9–14 days after the onset of motor symptoms, 6 (40%) showed TMS evoked responses on the paralyzed side (Table II). The recovery profile did not significantly differ between those with or without responses. With EES, the patients who showed a side-to-side MEP amplitude difference of $< 80\%$ had significantly ($p < 0.05$) better recovery than the patients with a greater difference of the amplitudes.

DISCUSSION

In Bell's palsy the primary nerve lesion takes place in the bony canal, most often in the labyrinthine segment (6). Within the first 3–5 days of the palsy, the extracranial part of the nerve, distal to the lesion, shows no or only relatively minimal degenerative changes (3). Therefore EES of the facial nerve at the stylomastoid foramen cannot reveal the extent of the neural lesion at that time (3, 7). Only after the distal degeneration of the nerve fibers has taken place, does EES provide information on the injury and the proportion of the degenerated facial nerve fibers (3). This explains the lack of EES evoked side-to-side MEP amplitude differences on days 0–4, and their development later on in this study.

Variable recording techniques and parameters of EES have been used to predict recovery from Bell's palsy (3, 8–10). In electric supramaximal stimulation of the facial nerve the amplitude of the response reflects the amount of functionally active nerve fibers/axons (3).

The estimation is made by comparing the amplitude of the paralyzed side to that of the healthy side. When evaluating recovery from the palsy, the 80%–95% side-to-side amplitude difference (related to certain time periods elapsed from the onset of the palsy) is usually regarded to be of importance (3, 11, 12). In our material, the amplitude differences of <80% or ≥80% on days 9–14, as compared to the 70% or 90% limits, gave the most distinct differences in the recovery profiles. However, the differences between these limit values were slight.

None of the electric methods has proven its usefulness for the early prognosis of the course of Bell's palsy during the first days after its onset. On the other hand, because TMS generates neural impulses proximal to the lesion of Bell's palsy, it might give information earlier, even before the distal degenerative changes have taken place. However, using TMS, Schriefer et al. (13) found no elicitable responses on the affected side in 15 out of the 16 patients with Bell's palsy, of which 10 had the duration of >14 days. Meyer et al. (14) found TMS responses in one of their 4 patients with <5 days duration of the palsy. These results were unencouraging, but also inconclusive, mainly due to the limited number of subjects and the criteria of selection. In our preliminary series we found patients in whom the responses were recordable within the first weeks of palsy (15, 16), and this encouraged us to continue with the present study.

Magnetically evoked responses have a considerable intraindividual as well as interindividual variation (17). In addition, the magnetic stimulation may not be supramaximal, and the MEPs are also influenced by facilitation (18). Therefore, the method as such is probably not suitable to quantitative estimation of the degree of nerve damage. On the other hand, MEPs produced by the generated nerve impulses suggest an incomplete conduction block in Bell's palsy. Based on these assumptions, we noticed only the presence or absence of TMS responses, and tried to use these findings in the prognosis of recovery from the palsy.

Within the first 4 days of the palsy, the side-to-side amplitude comparisons in EES were of no use in the prognostication of recovery, corresponding to the fact that the distal nerve degeneration is none or minor at this phase (3). However, on days 5–8 the respective amplitude difference between the two sides became significant, but could not yet predict recovery, probably because in this phase the on-going degeneration of the distal nerve could

Table II. TMS, EES, and final recovery according to the House-Brackmann (HB) grading

	Day					
	0–4		5–8		9–14	
HB	+	–	+	–	+	–
<i>TMS</i>						
1	9	1	6	10	6	6
2	0	1	2	0	0	1
3	1	3	0	3	0	2
<i>p</i>	0.023		0.078		0.287	
<i>EES (amplitude difference)</i>						
HB	<80%	≥80%	<80%	≥80%	<80%	≥80%
1	10	0	14	2	10	2
2	1	0	1	1	0	1
3	2	0	1	2	0	2
<i>p</i>	>0.5		0.085		0.025	

not yet sufficiently reflect the final condition of the nerve. Later on, on days 9–14, the relative amplitude differences still increased, and those who had a difference of < 80% showed significantly better final recovery than those with a difference of ≥ 80%. So, at this phase the progress in the degeneration process had probably leveled down, EES now better reflecting the final condition of the nerve and the final outcome of the palsy (3).

The patients who showed MEPs in TMS within the first 4 days of the palsy recovered significantly better than those without elicitable MEPs. Later on, the recovery could not be predicted in this way. The responses at the earliest stages of palsy probably reflect the extent of the primary injury, because the degeneration process does not play an essential role. Later on the response is influenced by the increasing extent of the conduction block, as the distal nerve degeneration proceeds, and the given nerve impulse has to traverse across both the primary injury and the segments impaired by degeneration. It is thus possible that the degeneration process and its effects on the MEPs of TMS makes it progressively more difficult, and after the first 4 days impossible, to predict recovery from the palsy with this method.

Bell's palsy constitutes an acute injury to the facial nerve function, with variable secondary effects both physically and socially. The illness causes serious disturbances, especially in the beginning. So, considering the possibilities for early therapeutic approaches in cases with a less favourable course, it would be desirable to estimate the possible recovery already within the first few days of the palsy. TMS of the facial nerve may be a method which could be of help in the early prediction of the outcome of the facial function in Bell's palsy.

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