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Prognostic Value of Somatosensory- and Motor-Evoked Potentials in Patients with a Non-Traumatic Coma

Josef Zentner[1] **and Alois Ebner**[2]

[1]Departments of Neurosurgery and [2]Clinical Neurophysiology, University of Freiburg, Medical School, D-7800 Freiburg i. Br., Federal Republic of Germany

Summary. A total of 28 patients with non-traumatic coma were studied both with somatosensory- and motor-evoked potentials. While somatosensory-evoked potentials (SEP) have proved to be useful in predicting the outcome in patients with severe brain damage, the aim of this study was to find out whether the additional evaluation of motor-evoked potentials (MEP) could contribute to a better prediction of the outcome than SEP alone. Our results clearly indicate that in terms of prognostic value, SEP are superior to MEP. Nine patients with bilaterally preserved MEP died, while all of the patients with bilaterally preserved SEP and a central conduction time ≤ 6.5 ms survived, with a Glasgow outcome score of 1 to 3. Therefore, we cannot recommend the inclusion of MEP in the prognostic evaluation of patients with non-traumatic coma.

Key words: Non-traumatic coma – Somatosensory-evoked potential – Motor-evoked potential

Introduction

The clinical assessment of comatose patients is often difficult, especially if sedatives for adaptation to respiration are administered. There have been many reports which demonstrate the prognostic value of somatosensory-evoked potentials (SEP) in traumatic and non-traumatic coma [2–5, 7, 9, 10–12, 14]. Data are lacking, however, on the usefulness of motor-evoked potentials (MEP) elicited by transcranial electrical stimulation [8] on this question. We studied 28 patients in non-traumatic coma with both SEP and MEP, to find out whether the additional evaluation of MEP could contribute to a better prediction of the outcome as compared with SEP alone.

Offprint requests to: J. Zentner, Neurochirurgische Universitätsklinik, Calwerstrasse 7, D-7400 Tübingen, FRG

Patients and Methods

A total of 28 patients (16 male, 12 female) aged between 3 and 75 years (mean age 47 years) were studied. All of the patients were comatose with a Glasgow coma score [13] ranging between 3 and 11 (Table 1). They were all intubated and artificially respirated. In 9 cases coma was due to subarachnoid haemorrhage; 14 patients suffered intracerebral space-occupying haemorrhage which was located supratentorially in 8 and infratentorially in 6 cases. Three patients were comatose due to diffuse cerebral ischaemia, hypoxia or both; 1 patient suffered from suicidal barbiturate intoxication and 1 other a fat embolism following a pelvic fracture. Seven of the patients were in a post-operative state, none of the others had undergone surgery. In 15 patients only single recordings were performed on the 1st to 3rd day of coma, in the remaining 13 patients serial recordings were done at 3- to 5-day intervals, but for prediction of the outcome only results of the first examination between day 1 to 3 after onset of coma were used. The outcome was evaluated according to the Glasgow outcome scale [6] (Table 2).

The SEP were recorded following electrical stimulation of the median nerve at the wrist. Stimulus strength was adjusted such that clear twitches of the thenar musle were visible. The stimulus rate was 5 Hz. The SEP were recorded simultaneously over the contralateral sensory hand area (C3'/C4') and over the upper cervical cord (C2), each referred to Fz. Averages consisted of 256–512 signals of 100 ms duration, which were filtered (2 Hz to 3 kHz) and repeated once or twice. Central conduction time (CCT) was determined by subtracting the latency of N14 from N20.

The MEP were recorded from the contralateral thenar musle using surface electromyograph (EMG) electrodes (belly/tendon fashion). Electrical stimulation was performed with voltage constant condenser discharges using a Digitimer 180,

Table 1. Glasgow coma scale [13]

Eye opening:	Best motor response:	Verbal response:
4 spontaneous	6 obey commands	5 orientated
3 to command	5 localize pain	4 disorientated
2 to pain	4 normal flexor	3 words
1 nil	3 abnormal flexor	2 sounds
	2 extensor	1 nil
	1 nil	

Table 2. Glasgow outcome scale [6]

1 Good recovery
2 Moderate disability
3 Severe disability
4 Permanent vegetative state
5 Death

which delivers a maximum output of 750 V with a time constant of alternatively 50 or 100 µs. In each patient both the motor cortex (anode over the motor hand area, cathode over the vertex) and the lower cervical spine (cathode over the intravertebral space C6/C7 and anode 6 cm laterally) were stimulated using commercial ECG electrodes with a diameter of 1 cm. Stimulus intensity was gradually increased until a clear EMG response was obtained or the absence of any response was documented.

The SEP were divided into four and the MEP findings into three categories: SEP type Ia meant preserved scalp responses on both sides with a CCT ≤6.5 ms, type Ib referred to preserved scalp responses on both sides with a CCT above 6.5 ms on at least one side. In type II the scalp response was absent on one side and in type III on both sides, while the neck responses were still preserved. MEP type I meant preserved EMG responses following transcranial stimulation on both sides. The EMG response was absent on one side in type II and on both sides in type III, while it was preserved after stimulation of the lower cervical spine. Figures 1 and 2 show examples of these SEP/MEP patterns.

Results

In all of the 28 patients the neck potential N14 of the SEP as well as the EMG response of the thenar muscle after stimulation of the lower cervical spine could be obtained. On the basis of these SEP/MEP patterns, we found that all 10 patients with SEP/MEP type Ia/I survived, with an outcome score of 1 to 3. Of the 3 patients with type Ib/I, 2 survived, though severely impaired, and 1 patient died. Of the 6 patients with SEP type II, 2 died and 4 survived with an outcome score of 4 and 3, respectively. All 9 patients with SEP type III died. On the other hand, 9 patients with MEP type I died and 14 survived with an outcome score of 1 to 4. The 2 patients with MEP type II sur-

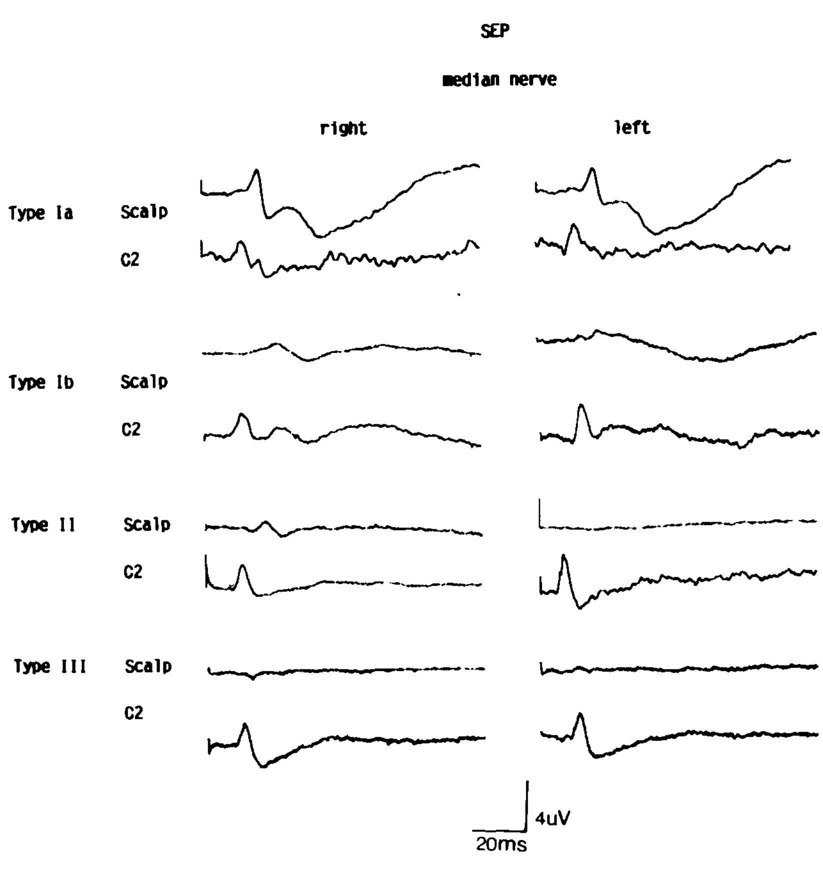

Fig. 1. Median nerve somatosensory-evoked potential (SEP) patterns. Recordings from 4 patients are shown. *Type Ia:* bilaterally preserved neck potential N14 and scalp potential N20, central conduction time (CCT) ≤6.5 ms. *Type Ib:* bilaterally preserved neck potential N14 and scalp potential N20, CCT > 6.5 ms on at least one side. *Type II:* bilaterally preserved N14, unilateral loss of N20. *Type III:* bilaterally preserved N14, bilateral loss of N20

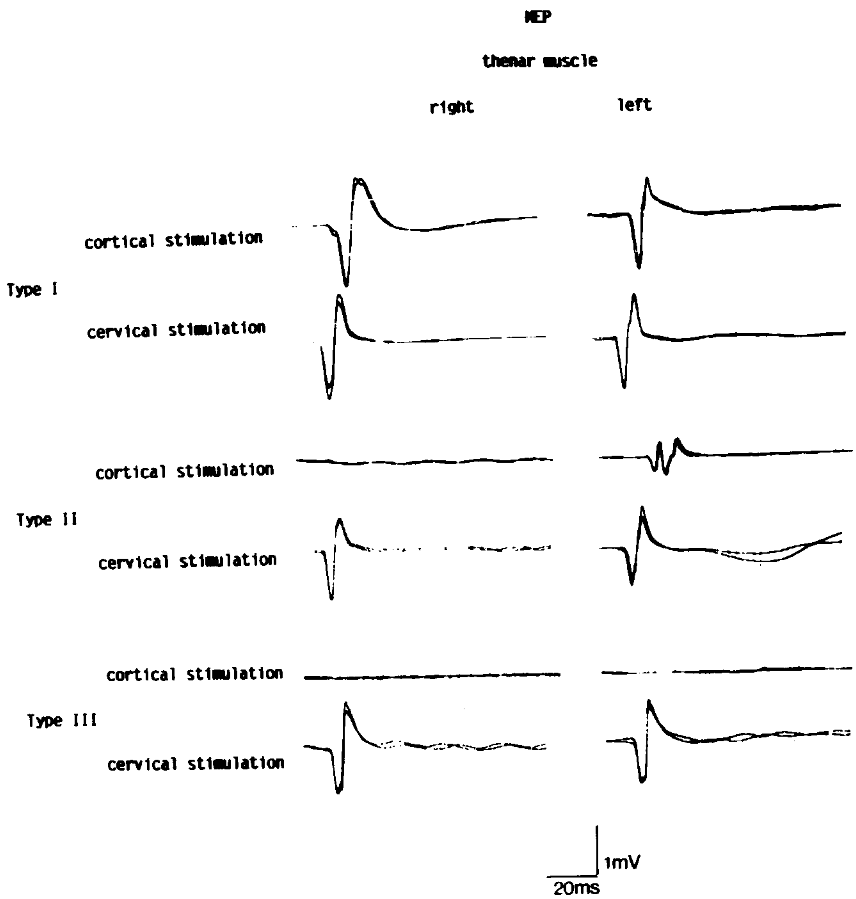

Fig. 2. Motor-evoked potential (MEP) patterns. Recordings from 3 patients are shown. *Type I:* bilaterally preserved electromyograph (EMG) response following cortical and lower cervical stimulation. *Type II:* unilateral loss of EMG response following cortical stimulation. The left thenar potential is of low amplitude and appears deformed as usually seen in this pattern. Bilaterally preserved responses following lower cervical stimulation. *Type III:* bilateral loss of EMG response following cortical, bilaterally preserved responses following lower cervical stimulation

Table 3. SEP/MEP types and Glasgow outcome score

Glasgow outcome score	SEP/MEP type												Total	
	Ia/I		Ib/I		II/I		II/II		III/I		III/III			
	n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%
1	4	40.0	–	–	–	–	–	–	–	–	–	–	4	14.3
2	5	50.0	–	–	–	–	–	–	–	–	–	–	5	17.9
3	1	10.0	–	–	1	25.0	–	–	–	–	–	–	2	7.1
4	–	–	2	66.7	1	25.0	2	100.0	–	–	–	–	5	17.8
5	–	–	1	33.3	2	50.0	–	–	6	100.0	3	100.0	12	42.9
Total	10	100.0	3	100.0	4	100.0	2	100.0	6	100.0	3	100.0	28	100.0

vived severely impaired. All 3 patients with MEP type III died (Table 3). Concerning the survival time, we found that the patients with SEP/MEP type III/I survived to an average of 19 days versus 11 days in patients with type III/III.

Discussion

Our results confirm the high prognostic value of SEP in patients with non-traumatic coma also described by others [4, 11, 14]. All of the patients with SEP type Ia survived with a Glasgow outcome score of 3 and less, and all of the patients with SEP type III died. Thus, SEP type Ia and III clearly predicted the outcome quoad vitam. Of the 6 patients with SEP type II, 2 died and 4 survived, though severely impaired.

Our central question was whether an electrophysiological assessment of the descending pathways obtained by transcranial electrical stimulation [8] might improve the prediction of the outcome of patients with severe brain damage. According to our results, it does not. As Table 3 shows, all patients with SEP type III died, regardless of the corresponding MEP type. The presence of MEP following transcranial stimulation seems only to predict a longer survival time (19 days in type III/I as opposed to 11 days in type III/III). It is remarkable, however, that MEP following transcranial electrical stimulation could be elicited in 6 patients in whom cortical SEP were absent. This indicates that it is possible to activate motor pathways when afferent somatosensory impulses do not reach the cortical level.

In 7 patients MEP were studied in the early postoperative state. However, the bone flap had been reimplanted in all of these patients and the craniotomy was not located between the two stimulation electrodes. In these cases the stimulus strength was cautiously increased, but to not more than half of the maximum output. In comparison with non-surgically treated patients we could not find a significant difference in stimulation strength necessary to elicit MEP. There is a possibility, however, that low resistance paths may give rise to foci of high charge density [1], therefore caution should be applied when these patients are stimulated until safe stimulus parameters have been established.

In conclusion, our results in patients with non-traumatic coma show that SEP with respect to the CCT have a much higher prognostic value than MEP. In MEP however, CCT cannot be evaluated by subtracting the latencies of the thenar potentials following transcranial and lower cervical stimulation as it depends to a high degree on the stimulus strength applied. Using higher stimulus intensities, one may stimulate lower parts of the descending pathways, thus shortening CCT. This could also explain the observation that MEP in some patients were still elicitable even when cortical SEP were abolished. Therefore, we cannot recommend the use of MEP for prognostic evaluation of patients with non-traumatic coma.

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References

1. Agnew WF, Mc Creery DB (1987) Considerations for safety in the use of extracranial stimulation for motor evoked potentials. Neurosurg 20:143–147
2. Cant BR, Hume AL, Judson JA, et al (1986) Reassessment of severe head injury by short latency somatosensory and brain-stem auditory evoked potentials. EEG Clin Neurophysiol 65:188–195
3. Greenberg RP, Becker DP, Miller JD, et al (1977) Evaluation of brain function in severe human head trauma with multimodality evoked potentials. Part 2. Localization of brain dysfunction and correlation with posttraumatic neurological conditions. J Neurosurg 47:163–177
4. Hume AL, Cant BR (1981) Central somatosensory conduction time after head trauma. Ann Neurol 10:411–419
5. Hume AL, Cant BR, Shaw NA (1979) Central somatosensory conduction time in comatose patients. Ann Neurol 5: 379–384
6. Jennett B, Bond M (1975) Assessment of outcome after severe brain damage: a practical scale. Lancet I:480–484
7. Lindsay KW, Carlin J, Kennedy I, et al (1981) Evoked potentials in severe head injury – analysis and relation to outcome. J Neurol Neurosurg Psychiat 44:796–802
8. Merton PA, Morton HB (1980) Stimulation of the cerebral cortex in the intact human subject. Nature 285:227
9. Narayan RK, Greenberg RP, Miller JO, et al (1981) Improved confidence of outcome prediction in severe head injury: a comparative analysis of the clinical examination, multimodality evoked potentials. CT scanning and intracranial pressure. J Neurosurg 54:751–762
10. Obeso JA, Masso JFM, Teijeira J (1980) On the meaning of a monophasic positive somatosensory evoked potential in deep coma. Electromyogr Clin Neurophysiol 20:343–349
11. Rumpl E (1985) Anwendung der SEP in der Intensivmedizin. Acta Neurol 12:53–57
12. Rumpl E, Prugger M, Gerstenbrand F, et al (1983) Central somatosensory conduction time and short latency evoked potentials in posttraumatic coma. Elektroencephalogr Clin Neurophysiol 56:583–596
13. Teasdale G, Jennett B (1974) Assessment of coma and impaired consciousness. A practical scale. Lancet II:81–84
14. Walser H, Mattle H, Keller MH, et al (1985) Early cortical median nerve somatosensory evoked potentials: prognostic value in anoxic coma. Arch Neurol 42:32–38

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