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PROGNOSTIC VALUE OF THE MULTIMODAL EVOKED POTENTIALS IN PATIENTS WITH HEAD INJURIES

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Summary. *The prognostic value of the multimodal evoked potentials (somatosensitive evoked potentials - SEPs, brainstem acoustic evoked potentials - BAEPs and visual evoked potentials - VEPs) were studied in 37 patients with head injury in the first 4 days after injury. The severity of injury was study by Glasgow Coma Scale (GCS). According to the Glasgow Outcome Score (GOS) all patients were classified as patients with good recovery, with moderate disability, severe disability and dead. The results of multimodal evoked potentials (MEPs) were confronted with GCS scores. Our results have shown that MEPs indicate poor prognostic outcomes in patients with GCS scores of 3 to 5 and those who had GCS scores of 6 to 8. The majority of patients with GCS scores 9 to 11 were discharged from hospital with moderate or mild disability. All patients who had GCS scores of 12 to 15 had good recovery. These results revealed that MEPs have early prognostic value in patients sustaining head injury.*

Key words: *Multimodal evoked potentials, head injury, prognostic, Glasgow Coma Score*

Introduction

Various methods have been used to improve the assessment of head injury including computerized tomography, intracranial pressure measurement, electroencephalography and evoked potentials. The clinical neurological examination, at present the most valid measure of CNS function, is of limited value when coma or confusion is presents, since patient cooperation is necessary for a complete examination. Information regarding long-term prognosis may be available from evoked potentials considered as indicators of general neurological status. Evoked potentials may disclose localized or specific injuries of the peripheral sense organs or nervous system in patients whose conditions prevent careful clinical examination (1,2,3,4).

Several approaches have been used in evoked potential studies in comatose and head injuries patients. Brain-stem auditory evoked potentials (BAEPs) have been shown to be highly resistant to systemic factors and toxic or metabolic derangements, making them particularly useful in differentiating reversible brain-stem dysfunction from that due to structural disruption. They have proved to be only fair predictors of the overall outcome, probably because the brain-stem resilence they reflect is not shared by the more vulnerable cerebral hemispheres. Somatosensory evoked potentials have been used alone, and visual evoked potentials as a prognosticator of eventual neurological outcome. The noninvasive nature and technical ease of the testing procedure make their application to the clinical setting quite feasible (5,6).

Predicting outcome after closed head injury is difficult because a neurological examination cannot reliably assess the disfunction of the brain in head injury (4).

Predictions rely on the Glasgow Coma Scale (GCS), which scores the motor response, presence of eye opening and speech. However, the GCS does not predict outcome reliably, and fails primarily in patients with severe head injuries because falsely pessimistic predictions are common.

We presented our observations based on a simplified multimodality approach applied to patients with head injuries. Our experience suggested that a combination of clinical results and multimodality evoked potentials (MEPs) data, may increase predictive reliability.

Materials and methods

Thirty seven patients with head injuries; aged 25-48 years who were treated in Neurosurgical Intensive Care Unit were studied. Thirty survived and 7 died in hospital. The survivors were treated for a mean period of 33 days. The median period of who died was 5 days.

The Glasgow Coma Score - GCS (Teasdale and Jennett, 1974) was recorded in period to 4 days in the Intensive Care Unit.

Somatosensory evoked potentials (SEPs), brainstem evoked potentials – BAEPs and visual evoked potentials (VEPs) were present in the first 4 days after injury.

Outcomes were assigned according to the Glasgow outcome score: "Good recovery", Moderate disability", Severe disability" and Death.

The SEPs were recorded on a Saffir-Medelec evoked potentials system using surface silver electrodes. Bandpass: 100-3 000 Hz, analysis time 50 ms. The central scalp electrodes (C4-C3) were placed 2 cm posterior to their 10-20 positions, while the neck electrode was placed over the seven cervical vertebra. The recording cortical and spinogram SEPs simultaneously following stimulation of the contralateral median nerve at the wrist was carried. Scalp and neck electrodes were referred to the mid-forehead (Fz).

BAEPs were recorded using alternately clicks of 0.1 ms duration delivered monaurally whit "masking" on the contralateral ear. Bandpass 100-3 000 Hz, analysis time 10 ms. The intensity of the click was 100 dB Hl. Electrodes were placed on the vertex and the medial aspect of each ear lobe.

VEPs were recorded using flash stimulation monocular. Bandpass were 10-300 Hz, analysis time 300 ms. Electrodes were placed 5 cm above inion, and referred to the Fz.

Normal standards for the SEPs, BAEPs and VEPs were used from our laboratory.

Two types of SEPs abnormality were recognised: absence of the scalp negative potentials (N19) or prolongation of the central conduction time (CCT), defined as the interval between the peak of the cervical negative potential (N13) and the peak of N19.

Three types of BAEPs abnormality were recognised: prolongation of the wave I-V interval, absence of wave V, and absence all waves without I.

VEPs abnormality were recognised: absence cortical response N75-P100-N145 or decrease of their amplitude.

The results of SEPs were graded in three types:

1. Normal bilaterally at least once and N19 never absent over either hemisphere.

2. Never normal bilaterally but N19 never absent over either hemisphere, i.e. CCT always prolonged on one or both sides (Fig. 1).

3. Absence of N19 over one or both hemispheres at any time (Fig. 2).

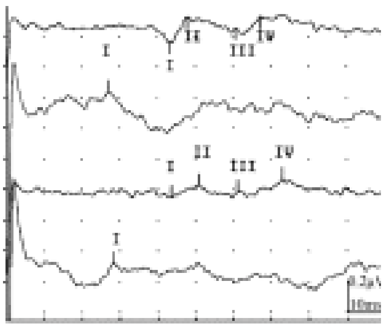

Fig.1. Gradus 2 of SEPs (trace 3 show abnormal response of right sensitive cortex)

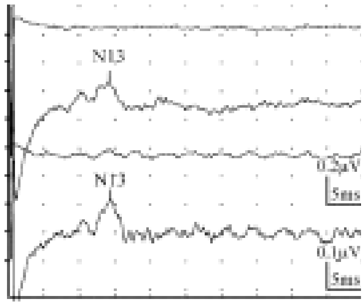

Fig. 2. Gradus 3 of SEPs (Trace 1 and 3 show absence response N19 bilaterally)

The results of BAEPs were graded in three types:

1. Normal bilaterally at least once and wave V never absent from either side.

2. Never normal bilaterally and wave V. never absent from either side, i.e., I-V interval prolonged or waves I and III not recorded. (Fig. 3, 4).

3. Absence of all waves without wave I (Fig. 5).

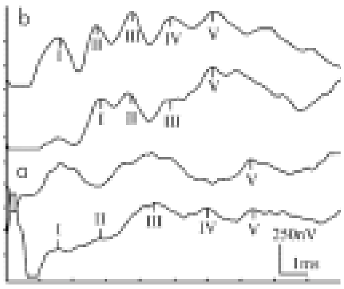

Fig. 3. Gradus 2 of BAEPs
(trace 4 show abnormal response of left acoustic tract)

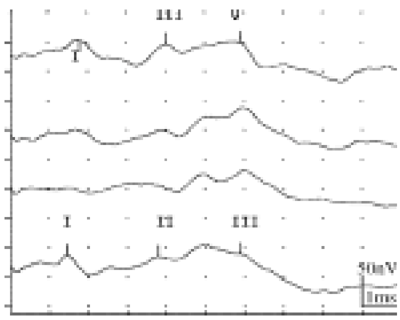

Fig. 4. Gradus 2 of BAEPs (trace 1 and 4 show abnormal response of both acoustic tracts)

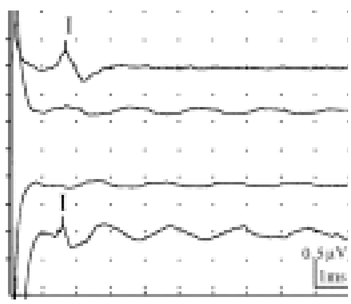

Fig. 5. Gradus 3 of BAEPs
(1 and 4 traces show only I response of acoustic tracts)

The results of VEPs were graded in two types:

1. Normal responses unilaterally with a decrease of amplitude (Fig. 6).
2. Absence all waves bilaterally.

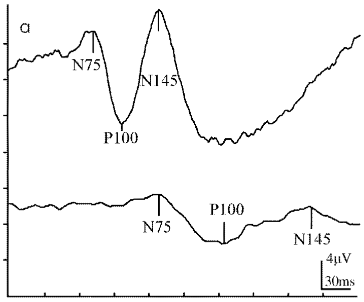

Fig. 6. Gradus 2 of VEPs (trace 2 show abnormal response of left visual cortex)

Results

The prognostic value of the MEPs findings was investigated by correlating them with the Glasgow Come Score (GCS) and the outcome according to the Glasgow Outcome Score (GOS) (Table 1 and Table 2).

Table 1. The relationship between MEPs and GCS in 37 patients with head injuries

MEPs	Score GCS			
Grade	3-5 N (7)	6-8 N (2)	9-11 N (13)	12-15 N (15)
SEPs1			5	12
SEPs2		2	8	3
SEPs3	7			
BAEPs1			3	10
BAEPs2		2	10	5
BAEPs3	7			
VEPs1			13	15
VEPs2	7			

N- number of patients

Table 2. The relationship between MEPs and outcome (GOS) in 37 patients with head injuries

MEPs	Outcome			
Grade	Good recovery	Moderate disability	Severe disability	Death
SEPs1	17			
SEPs2		11	2	
SEPs3				7
BAEPs1	15			
BAEPs2		13	2	
BAEPs3				7
VEPs1	15	13		
VEPs2				7

All patients were graded according to GCS scores. Somatosensitive evoked potentials as well as BAEPs were measured in 37 patients but VEPs were comprised 35 cases.

Seven patients having had GCS of 3 to 5 were classified as grade 3 (the highest degree of abnormalities) according to the results of measurements of SEPs, BAEPs and VEPs. All patients in this group died (Table 1).

Two patients with GCS scores of 6 to 8 had the grade 2 of SEPs and BAEPs (slightly lower degree of abnormalities) and survived with serious brain sequels such as: sever right side weakness in one patient and the signs and symptoms of pseudobulbar paralysis in the second one. None of them had VEPs measurements (Table 2).

Thirteen patients with GCS scores of 9 to 11 were classified in the third group; five of them showed grade 1 of SEPs (normal findings) indicating good recovery. In 8 other cases the results of measurements of SEPs were grade 2 suggesting some brain lesions. However eleven patients were discharged from the Clinic with moderate disability according to GOS scores, and only 2 had good recovery at the discharge.

The results of BEAPs were as follow: three patients had grade 1 indicating good recovery and 10 cases had grade 2 (abnormal findings) showing some kind of brain lesions. But in spite of the above measurements all patients had moderate disability according to the GOS score.

In this group all patients had normal VEPs measurements and were classified as grade 1 in the final outcome (Table 2).

The group of 15 patients with GCS scores of 12 to 15 was classified in the last batch. In 12 of them the results of SEPs were normal (grade 1) with good recovery, three patients had grade 2 indicating mild lesions of the brain. However all patients in this group had good recovery without neurological deficit.

In patients with GCS scores of 12 to 15 the findings of BAEPs were as follows: ten patients had grade 1, and 5 cases were in grade 2 suggesting moderate disabilities. However all patients were discharged from hospital with good recovery.

The head injured patients with GCS scores of 12 to 15 having been in grade 1 of VEP measurements had a good recovery at the discharge from our hospital (Table 2).

Discussion

The clinical examination within the first 24-72 h after head injury can accurately identify some patients who will die and some who will make a good recovery. There is thus a need for reliable indices of the severity of brain damage, which can be used both to assess patients and to monitor their progress (10,11,17). Neurophysiological techniques utilizing sensory evoked potentials have proven increasingly valuable in providing such information. The reliability and usefulness of here ultimately depend upon correlation with the final outcome (1,2). The use of MEPs to confirm a diagnosis and prognosis of head injury has many advantages: MEPs can be rapidly performed at the patients bedside, assess the brain stem as well as the cerebral cortex, and are innocuous for the patient. On the other hand, MEPs are reliable, accurate and a safe confirmatory test, especially under misleading conditions (hypothermia, drugs, metabolic disturbances) (5,6,7,8,9).

The multimodal evoked potentials (MEPs) tests are very valuable for patients in head injuries evaluation in 3 fundamental aspects: diagnosis, prognosis and neuro-monitoring of the cerebral function. (18,19).

Maguiere et al. (12) showed deep reversible BAEPs alterations following the association of barbiturates and xylocaine in one case. Nevertheless, for Chiappa (11), BAEPs provide a sufficient safety margin to be used in comatose patients and remain an indicator of a preserved brain-stem function in difficult clinical situations. SEPs are also poorly affected by CNS-depressant drugs. Increased latencies with increased central conduction time have been observed in meprobamate and nitrazepam overdose (11,13,14,15).

Our results demonstrate the value of SEPs in the assessment of head injuries. Unilateral or bilateral absence of N19 (grades 2) at any stage in the first 4 days is usually associated with an unfavorable outcome. A number of studies have now shown that the transit time within the central somatosensory pathways tends to be increased following head trauma and the extent of the delay is proportional to the severity of the injury. In patients who survive, the CCT will gradually return to normal during recovery (1,2,3).

The present comparative study shows that BAEPs do not provide as accurate an assessment of head injuries as do SEPs. Little additional prognostic information therefore seems to be gained by recording BAEPs as well as SEPs.

The results of MEPs measurements in our study were very confirmative and good indicator in patients with unfavorable outcomes as well as in those who succumb. In patients with GCS scores of 3 to 5 and of 6 to 8 all measurements showed the highest level of abnormalities, having been in the grade 3 in the first 4 days after injury.

There are some investigations showing different predictive values of the above measurements. Cant et al. (1986) have stressed that SEPs have the greater predictive value and significance due to the higher possibilities of the lesions of the Somatic Sensory Pathways from the cervical part up to the Cerebral Cortex in relation to BAEPs whose pathways are limited only to the Brain Stem. The degree of abnormalities of SEPs is proportional to the degree of damage of the neural transmission better to say the cerebral dysfunction of the CNS.

Others stressed that continuous monitoring of SEPs in patients sustained head injuries in the first 4 days is very useful and an indispensable monitoring method that could be used as complementary with the clinical findings which is vary from one moment to the other and from one day to the other. Very early the monitoring of SEPs may be of value pointing out clinical outcome in patients with head injury with high probability (9,10,12).

The results of VEPs were normal in our group of patients with GCS scores of 9 to 11 and in those who survived injury with mild cerebral lesions (mild motor deficit) in contrast to SEPs and BAEPs measurements indicating unfavorable outcomes. These results direct to the existence of scattered multifocal lesions of the CNS especially in the brain stem.

The group of patients having had GCS scores of 12 to 15 who had the measurements of all three modalities of evoked potentials evidently showed a clear correlation with outcomes in patients with head injury especially of VEPs. These results can be interpreted in the light of facts that the majority of microlesions were localized infratentorialy in the brain stem rather than supratentorialy. This is the reason why the number of patients with abnormal findings were in group of SEPs and BAEPs (five out 15 in SEPs and 3 out of 15 in BAEPs) in contrast to of the measurements of VEPs that were normal in all patients.

Finally, MEPs have a different predictive value in patients who sustained head injuries. The high predictive value and clear correlation with GCS scores evidently showed all test with evoked potentials in group of patients with the lower level of GCS scores as well as in the group of patients with the highest GCS scores which was on contrary to the patients with GCS scores of 9 to 11 where the predictive values of MEPs were less predictive.

In conclusion, our study shows that SEPs, BAEPs and VEPs are powerful tools for predicting the clinical course in head injury patients. MEPs predict deterioration of the clinical course, and predict improvement in patients. Thirdly, no change in the clinical course according to clinical scales.

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PROGNOSTIČKA VREDNOST EVOCIRANIH POTENCIJALA KOD POVREDE GLAVE

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Kratak sadržaj: *Prognostička vrednost multimodalnih evociranih potencijala (somatosenzitivnih evociranih potencijala kratkih latencija - SEP, akustičnih evociranih potencijala moždanog stabla-AEP i vizuelnih evociranih potencijala -VEP), ispitivana je kod 37 pacijenata sa povredom glave. Multimodalni evocirani potencijali mereni su u periodu do 4 dana nakon povrede. Stepen poremećaja svesti procenjivan je Glazgov koma skalom u istom periodu. Ishod povrede određivan je prema Glasgow ishod skali po kojoj su svi pacijenti grupisani u 4 grupe: sa dobrim oporavkom, lakšim oštećenjima, težim oštećenjima i smrt. Rezultati multimodalnih evociranih potencijala uporedjivani su sa skorom Glazgov koma skale i Glazgow ishod skale. Naši rezultati pokazuju da su multimodalni evocirani potencijali ukazali na loš ishod povrede u grupi pacijenata sa najnižim skorom GC (skor 3-5), na teza neurološka oštećenja u grupi pacijenata sa skorom 6-8, lakša neurološka oštećenja u grupi sa skorom 9-11 i dobar oporavak u grupi pacijenata sa skorom 12-15 u prva 4 dana od povrede. Autori zaključuju da multimodalni evocirani potencijali imaju rani prognostički zanačaj kod pacijenata sa povredom glave.*

Ključne reči: *Multimodalni evocirani potencijali, povreda glave, prognoza, Glazgow koma skor*