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A. Vrca · V. Božikov · Z. Brzović · R. Fuchs
M. Malinar

Visual evoked potentials in relation to factors of imprisonment in detention camps

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Abstract Visual evoked potentials (VEPs) of the pattern shift reversal type were determined in a representative group of 57 prisoners of war (POWs) released in 1992 from detention camps in former Yugoslavia. The parameters were correlated with the conditions in four camps (1–4). All subjects were male, with a mean age of 34.75 years (SD ± 8.92), average length of imprisonment 192.7 days (SD ± 77.6), mean loss of body mass during imprisonment 19.32% (SD ± 9.54), and the average number of reported blows to the head and neck was 25.7 (SD ± 20.3). VEPs were determined on average 290.5 days after the last craniocerebral trauma caused by blows to the head and neck (SD ± 152.0) i.e. on average 218.5 days after release from the camp (SD ± 164.3). Although all the 57 POWs reported being maltreated to a certain extent, 14 reported being subjected to particularly brutal forms of torture, 5 had been held in solitary confinement and 25 had lost consciousness at least once. Solitary confinement and loss of consciousness had the most significant effect on VEPs, and the altered VEP parameters correlated significantly with the craniocerebral trauma experienced, loss of body mass and the length of time since the last craniocerebral trauma until examination, and from release until examination. However, the length of imprisonment and treatment in the camps did not have a significant effect on VEP parameters. The study confirmed that under such conditions the age of the subject is a risk factor. The results of this study also confirmed that prisoners in one camp had been subjected to the worst maltreatment.

A. Vrca (✉) · R. Fuchs · M. Malinar
Institute for Medical Research and Occupational Health,
2 Ksaverska cesta, 10000 Zagreb, Croatia

V. Božikov
Clinical Hospital Dubrava, Aleja Izviđaća bb,
10000 Zagreb, Croatia

Z. Brzović
Clinical Hospital Centar Rebro, Kišpatićeva 12,
10000 Zagreb, Croatia

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Introduction

In the former Yugoslavia during the years 1991 and 1992, a large number of detention camps were organized and used to detain members of the civilian population. In these camps prisoners of war (POWs) were subjected to physical and mental torture, and several hundred died. After release from the camps the majority showed signs of deteriorated mental and physical health, which can be detected by evoked potentials of the brain [2, 3, 8, 9, 11, 13, 14], a very sensitive neurophysiological technique. The method is particularly valuable because the subjective factor is excluded and because the so-called subclinical aspect is included by examining nervous system functions.

The aim of this study was to use visual evoked potentials (VEPs) to determine which conditions in detention camps could be regarded as the cause of the changes found, in order to better understand the mechanism initiating VEP changes [4, 6, 7, 10]. The study was aimed at identifying the forensic-medical significance of these changes, with the object of monitoring the health status of the POWs and observing the effect of treatment.

Subjects and methods

The study group was comprised of 57 male POWs after release from detention camps in 1992. After a general medical examination, carried out within 15 days of release, almost every tenth prisoner required hospitalization. Approximately 1,500 of the 6,500 released POWs were examined by a neurologist, 350 of them in the Institute for Medical Research and Occupational Health, Zagreb. A neurological examination was indicated for all those with diagnosed or suspected neurological impairment, those who had lost consciousness during imprisonment for any reason and those who reported being beaten on the head and neck during imprisonment.

For this study 57 POWs were selected at random from the group of 350 examined in the Institute for Medical Research and

Table 1 Pattern shift reversal type visual evoked potentials in 57 (n = 114 eyes) prisoners of war released from detention camps

L = wave latency
A = wave amplitude

	P50 wave		N75 wave		P100 wave		N145 wave	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
L	54.46	4.64	78.94	4.45	110.05	6.30	148.88	8.94
A	2.15	1.16	5.07	2.37	5.38	2.90	1.81	1.50

Occupational Health. VEPs were examined on average 218.5 days after release (SD ± 64.3). The average duration of imprisonment was 192.7 days (SD ± 77.6), the average number of blows to the head and neck 25.7 (SD ± 20.3), the relative loss of body mass 19.32% (SD ± 9.54), and the time passed since the last craniocerebral trauma to determination of VEPs was 290.5 days (SD ± 152.0).

During imprisonment many of the POWs were moved from camp to camp. Of the 57 POWs in this study 14 reported being subjected to particularly brutal maltreatment, (beaten with wooden or metal clubs, punched or kicked, most frequently in the face, forehead and neck, lumbar and gluteal region and genitals, electric shocks, carried out by connecting the fingers, toes or genitals to an electric generator of a field telephone, exposure to high or low temperatures without clothing, intense light and noise, hanging by the arms or legs, prevention of sleep and rest, forced to carry out obscene acts and other forms of mental torture), 5 were held in solitary confinement and 25 lost consciousness at least once.

None of the POWs had previously been criminally charged or imprisoned, treated for chronic disease, suffered serious injury to the head and neck, or had lost consciousness prior to imprisonment. None of the subjects had ever had eye problems or worn spectacles permanently; the largest refractory anomaly was +1.5 in one subject. None of them had taken medication over long periods, and those taken were usually analgesics or antibiotics.

VEPs were determined using a brain imager (Vickers Medcial, England) by stimulating each eye by checkerboard reversal stimuli on a screen. The angle at which the subject covered the whole field of stimulation was 8° and each quadrant was 1°. Intensity of the contrast of light and dark fields was 92% and the permanent light intensity in the darkened room was 0.05 Cd^2/m. Responses were detected over the primary visual cortex by an O_z electrode (10–20 international system), and a reference electrode was attached to the earlobe. The limits for filtering responses were 1.05–80 Hz. All responses occurring within the first 300 ms of stimulation were recorded. Amplitudes and latencies were determined for waves P50, N75, P100 and N145 (Table 1). Data were statistically analysed by the Mann-Whitney U-test and Spearmann rank correlation for each eye separately (114 samples), and the difference was considered significant when P was less than 0.05 [1].

Table 2 Significance of the difference in VEP parameters in 57 prisoners of war released from four detention camps, in relation to imprisonment in each camp

↑ = Significant increase
↓ = Significant decrease
L = Wave latency
A = Wace amplitude
NS = Not significant

Detention camp		P50 wave	N75 wave	P100 wave	N145 wave
Camp 1	L	NS	NS	NS	NS
(n = 21)	A	NS	NS	NS	NS
Camp 2	L	NS	$P < 0.05$ ↑	NS	NS
(n = 21)	A	NS	NS	NS	NS
Camp 3	L	NS	NS	NS	NS
(n = 7)	A	NS	NS	NS	NS
Camp 4	L	NS	NS	NS	NS
(n = 10)	A	NS	$P < 0.01$ ↓	NS	NS

Results

VEPs did not essentially differentiate the POWs released from camps 1 and 3 from the other POWs. However the POWs released from camp 2 had a significantly longer latency of the N75 wave compared to other POWs, and POWs released from camp 4 had significantly lower amplitudes of the N75 wave compared to other POWs (Table 2). No significant differences were found in the VEP parameters between those POWs who had reported being subjected to particularly brutal forms of torture and those who had not (Table 3). The POWs who had been held in solitary confinement during imprisonment had significantly longer latencies of waves N75 and P100 and significantly higher amplitudes for waves P50 and N145 and those who had lost consciousness during imprisonment had significantly longer latencies of waves P50 and N75 compared to other POWs (Table 3). The length of imprisonment in the camp did not have a significant effect on VEPs. However, the craniocerebral trauma experienced (blows to the head and neck) showed a significantly positive correlation with the latencies of waves P50 and P100 (Table 4). Loss of body mass during imprisonment showed a positive correlation with the latencies of waves P50 and

Table 3 Significance of the difference in VEP parameters in 57 prisoners of war released from detention camps in relation to treatment during imprisonment

↑ = Significant increase
L = Wave latency
A = Wace amplitude
NS = Not significant

		P50 wave	N75 wave	P100 wave	N145 wave
Torture	L	NS	NS	NS	NS
(n = 14)	A	NS	NS	NS	NS
Solitary confinement	L	NS	$P < 0.05$ ↑	$P < 0.01$ ↑	NS
(n = 5)	A	$P < 0.05$ ↑	NS	NS	$P < 0.05$ ↑
Loss of consciousness	L	$P < 0.05$ ↑	$P < 0.05$ ↑	NS	NS
(n = 25)	A	NS	NS	NS	NS

Table 4 Significance of the correlation between age, duration of imprisonment, loss of body mass, number of blows to the head and neck, time elapsed since the last blow to the head and neck and release, time elapsed since release to determination of visual evoked potentials and VEP parameters in 57 prisoners of war released from detention camps

		P50 wave	N75 wave	P100 wave	N145 wave
Age (in years)	L	NS	$P < 0.05$ ↑	NS	$P < 0.05$ ↑
	A	NS	$P < 0.001$ ↓	$P < 0.05$ ↓	NS
Duration of imprisonment (in days)	L	NS	NS	NS	NS
	A	NS	NS	NS	NS
Loss of body mass (in %)	L	$P < 0.05$ ↑	$P < 0.05$ ↑	NS	$P < 0.001$ ↓
	A		$P < 0.05$ ↓	$P < 0.01$ ↓	NS
Number of blows to the head and neck	L	$P < 0.01$ ↑	NS	$P < 0.01$ ↑	NS
	A		$P < 0.05$ ↓	NS	NS
Time elapsed since the last blow to the head and neck and release (in days)	L	NS	NS	NS	NS
	A	NS	NS	NS	NS
Time elapsed since release to determination of visual evoked potentials (in days)	L	$P < 0.05$ ↑	$P < 0.001$ ↑	NS	NS
	A	NS	NS	NS	NS
Time elapsed since the last cerebrocranial injury to determination of visual evoked potentials (in days)	L	$P < 0.05$ ↑	$P < 0.01$ ↑	NS	NS
	A	NS	NS	NS	NS

↑ = Significant positive correlation
↓ = Significant negative correlation
L = Wave latency
A = Wace amplitude
NS = Not significant

N75 and a negative correlation with the latency of wave N145 and amplitudes of waves N75 and P100. The time elapsed since the last recollected craniocerebral trauma in the camp to examination of VEPs and the time elapsed since release from the camp to examination of VEPs showed a significant positive correlation with the latency of waves P50 and N75. However the time elapsed since the last craniocerebral trauma to release from camp did not have a significant effect on VEP parameters (Table 4).

Discussion

For this study the following factors of imprisonment were examined:

1. Factors which, to a certain extent, can be shown with a high degree of objectivity for all the POWs released (length of imprisonment, time elapsed since release to determination of VEPs, and loss of body mass).
2. Factors with a lesser degree of objectivity for all the POWs released (craniocerebral trauma, time elapsed since the last trauma to release, time elapsed since the last trauma to determination of VEPs).
3. Factors which were not experienced by all the POWs and which have varying degrees of objectivity (particularly brutal forms of torture, solitary confinement, loss of consciousness, imprisonment in several camps).
4. Factors which were considered to have an effect on VEPs, regardless of the camp (age, sex).

The results of this study demonstrate that the number of blows to the head and neck, i.e. craniocerebral injury/trauma, had the most marked effect on VEPs. This can probably be explained by the fact that the POWs were most frequently struck in the occipital region and face causing the head and neck to twist in an anterio-posterior direction, frequently injuring the calcarineus. This is the location of the primary visual cortex and the site of VEP wave registration. This can also cause maximal mechanical burdening of the visual pathways which are primarily positioned in the same anterior-posterior direction, causing stretching, tightening and eventual tearing [4, 7].

Correlation of VEP changes with loss of body mass was anticipated, the most likely mechanism of which is changed body metabolism and loss of essential neuroprotective substances. Age represents a greater risk of changed VEP parameters in camp conditions, presumably because of poorer adaptability [4, 7, 10].

The insignificance of the length of imprisonment on VEPs was unexpected, although to a certain extent explicable. According to the released POWs maltreatment did not occur every day but the number, type and intensity depended more on the whim of the camp guards. Maltreatment was most intensive in the early days of imprisonment, during so-called questioning and on significant religious and national dates. Maltreatment also intensified in accordance with events on the war front. In such circumstances it was possible for POWs with the same length of imprisonment to experience quite different „treatment" in the camps [8, 9, 11–13].

The results of this study stress the powerful influence of solitary confinement and loss of consciousness on VEP parameters. As loss of consciousness usually occurred after blows to the head and neck, the extent of the craniocerebral injuries was as important as the number of blows [7–9].

Although it would be expected that the group of POWs who had suffered particularly brutal forms of torture would have markedly changed parameters of VEPs this was shown not to be the case, and can partly be explained by the fact that after their release from camp the POWs had confused recollections of their experiences in camp,

often quite different from the reality, indicating the possibility of an unconscious desire to repress the memory particularly in cases of sexual maltreatment [11–13].

Although the results of this study indicate that the camps did not differ essentially, the POWs held in camp 2 were more likely to have changed VEPs than the POWs from other camps.

A strong positive correlation was found between the changed VEP parameters in POWs and the time elapsed since the last craniocerebral injury in the camp to determination of VEPs, and the time elapsed since release to examination of VEPs. This corroborates the fact that the changes continued regardless of the fact that the POWs were no longer exposed to camp conditions.

The authors speculate that the mechanism provoking the changes is most likely demyelinization of intrathecal structures of the nervous system as a consequence of immunological changes occurring in conditions of intense, prolonged psychophysical fear in the camps. Dekaris et al. found immunological changes in a representative group of POWs from detention camps, which agrees with the above speculation [5].

Although the altered VEPs were not specific, greater changes were observed in the earlier waves (P50, N75 and P100) compared to the later waves (N145) which indicates structural rather than functional changes throughout the visual pathway.

Immediately prior to determination of VEPs none of the POWs complained of subjective eye disorders and such disorders were not detected during a routine examination, indicating that the VEP changes in this group of subjects can be regarded as subclinical [4, 7].

The POws will be followed-up in order to determine whether the VEP changes will regress, become more marked, or will acquire certain clinical correlates, and whether the changes will consequently emphasize certain factors of imprisonment or subgroups of POWs [4, 7].

The following conclusions can be drawn:

1. Changes in the VEP parameters of POWs released from detention camps occur in parallel with certain factors of imprisonment.
2. The changed VEP parameters show a progressive trend even after release from the camps.
3. Imprisonment in camp 2, solitary confinement and loss of consciousness have a greater predisposition to cause VEP changes in the POWs.
4. Based on subjective symptomatology and the results of a routine examination immediately before determination of VEPs, the changes can be regarded as subclinical.
5. It can be speculated that the alterations in VEPs are probably provoked by an intrathecal demyelinization process, occurring as a consequence of immunological changes during prolonged, intense psychophysical stress during imprisonment in detention camps.

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