

ELECTROENCEPHALOGRAPHY IN WORKERS EXPOSED TO CARBON DISULPHIDE

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ABSTRACT

The aim of the study was to find out EEG changes in the sense of the shift of dominant frequency (DF) and amplitude voltage during the exposure of workers to CS₂. For the study 20 newly employed workers from the staple cell production were selected. The control group consisted of 21 non-exposed workers.

The EEG was recorded on magnetic tape and evaluated by Van Gogh analyzer. In a four-year period the recordings were performed six times.

The results obtained in newly employed workers showed that CS₂ exposure produces an increase in DF, i.e. an acceleration of electrocortical activity.

Mikishova and Mikiska demonstrated that EEG could be recorded on magnetic tape and analyzed by means of the frequency/voltage ratio which enabled the use of EEG for clinical detection of CS₂ poisoning¹.

Our investigation is based on a previous study on experimental animals². The electroencephalograms were recorded in rats before and during daily administration of CS₂ in the course of six weeks. The electroencephalograms were analyzed by passing the tape recorded signals through a 6-15 band pass filter into an amplitude discriminator to indicate the number of occurrences in frequency units. Significant changes occurred in the tape recorded tracing. These changes, which consist of an increase in frequency and bursts of high amplitude were shown to precede clinical signs and became progressively more pronounced as the toxic exposure of the animal increased. At the time of partial paralysis the dominant frequency of 9 cycles per second (cps), observed in the normal animal, had shifted to 14 to 16 cps.

We applied the same method in exposed workers to find out if this technique can provide early diagnostic information about the development of central nervous system affection.

SUBJECTS AND METHOD

For this investigation a group of 20 newly employed workers from the operation of staple cell rayon production was selected. The average age of workers was 23.5 ± 5.2 years. This group was followed during a period of four years in which time EEG was recorded on six occasions (Group I). At the beginning of the study a single recording was made in a group of 17 workers from the same operation. The exposure of this group was longer than 10 years and average age was 40.5 ± 5.5 years (Group II). EEG was also recorded only once in a group of 22 disabled workers (invalids), average age 42.5 ± 4.9 years, who were previously poisoned and then removed to non-exposed workplaces (Group III). The latter two groups served for comparison with the first group. The control group consisted of 21 workers, average age 34.9 ± 3.2 years, who were not exposed to CS₂. The workers from the control group were followed in the same way as the group of newly employed workers.

We used the following equipment: portable eight channel EEG Beckman, Honeywell portable tape recorder, Van Gogh frequency analyzer with eight selective amplifiers, phono and photo stimulator.

The EEG recordings were performed by means of 12 electrodes which were placed according to the eight channel routine programme/montage I/. During the recording the signals were registered at the same time on tape recorder and on paper. The EEG investigation included: EEG at rest five minutes, hyperventilation three minutes, phonostimulation three minutes recorded on channel I – the phonostimulator adjusted on one impulse every two seconds, and photostimulation three minutes recorded on channel II – the photostimulator adjusted on one impulse every two seconds. Phono- and photostimulation were recorded by means of a selector.

The conditions of recording were: time constant 0.1; filter 50 microvolts; gain 7; speed of the paper 30 mm/sec. The tape recorded data were evaluated by means of Van Gogh analyzer modified to give data on DF in the spectrum of 5.4 to 14.8 cps and with Beckman recorder.

Analyzers had eight selective amplifiers and divided recorded signals with central frequency of 5.5, 6.3, 7.2, 8.3, 9.6, 11.1, 12.8 and 14.8 cps. Each selective amplifier included an integrator which gave average values of the level of signals for the planned period of 30 seconds.

Duration of recording of EEG at rest was five minutes. For each recording eight 30 second analyzes were performed, and average values were calculated. At the time of recording workers were medically examined and iodine azide test in urine was performed.

RESULTS

The results of the first recording of EEG at rest are presented in Table 1. Among the groups in the study an obvious difference in the percentage and type of dominant frequency was observed. In a high percentage of newly employed workers (Group I, 75%) the frequency of 9.6 cps was dominant. The other frequencies such as 8.3 and 11.1 cps appeared rarely. With the increase in the

TABLE 1
Dominant frequency at first recording in observed groups (percentage of subjects).

DF in cps	I group	II group	Invalids	Control
8.3	10.0	13.3	0.0	4.8
9.6	75.0	33.3	13.6	61.9
11.1	15.0	41.1	63.6	33.3
12.8	0.0	13.3	13.6	0.0
14.8	0.0	0.0	9.1	0.0

duration of exposure DF increased so that in Group II a DF of 11.1 cps was established in 41.1 per cent of workers. In some workers from this group DF achieved a value of 12.3 cps.

The greatest difference in DF was observed between newly employed workers and invalids. In more than 60 per cent of invalids the frequency of 11.1 cps was dominant. In some subjects a DF of 14.8 cps was also registered.

In the control group the prevalence of DF of 9.6 cps was evident.

Table 2 shows the distribution of DF at first and last recording in Group I.

TABLE 2
Distribution of dominant frequency (DF) at first and last recording in Group I.

DF in cps	First recording	Last recording
	Percentage of subjects	
8.3	10.0	5.0
9.6	75.0	50.0
11.1	15.0	45.0

At the end of investigation we established a shift in DF in relation to the first recording. After a few years of exposure to CS₂ DF increased in almost half of the newly employed workers. The acceleration of DF varied from 1.5 to almost 3 cps. A shift in DF appeared most frequently during the fifth and sixth recording i.e. after three and four years of exposure. Analysis of hyperventilation data showed no significant difference between EEG at rest and hyperventilation.

Among newly employed workers 45 per cent had an accelerated DF, while among the workers from the control group no acceleration in DF was detected. In newly employed workers besides DF acceleration in two cases (10%) a retardation of DF was also established. In the control group a retardation of DF appeared also in two cases.

TABLE 3
Microvoltage ($\bar{X} \pm$ S.D.) in observed groups.

Group I		Group II	Invalids	Control
First recording	Last recording			
14.2 ± 6.7	10.7 ± 6.2	9.9 ± 6.8	9.3 ± 7.9	12.9 ± 7.7

Table 3 shows the mean values and the standard deviation of microvoltage (μ V) at first recording in observed groups. The difference in mean μ V values between Group I and two other groups is evident. The lowest μ V value appeared in the group of invalids. The mean μ V value in the control group was between the values established for Groups I and II.

Table 4 shows μ V values at first and last recording for the newly employed workers. This group was divided in two subgroups according to the shift in DF: subgroup A without a shift in DF, and subgroup B with an acceleration of DF. At the beginning of the study no important difference in μ V values between the

TABLE 4
Microvoltage at first and last recording in Group I (percentage of subjects).

Microvoltage	Subgroup A		Subgroup B	
	First recording	Last recording	First recording	Last recording
0.0- 0.5	0.0	0.0	0.0	44.4
5.1- 10.0	33.3	22.2	44.4	44.4
10.1- 20.0	33.3	44.4	44.4	11.1
> 20.1	33.3	33.3	11.1	0.0

subgroups was observed; no subject showed a value below 5 μ V. After four years of exposure to CS₂ the difference in μ V between the two subgroups started to be evident. In subgroup A there was still not a subject with a value below 5 μ V, and in subgroup B almost half of the subjects showed values lower than 5 μ V. Signals obtained by photo- and phonostimulation were not analyzed.

The level of workers' exposure to CS₂ was determined in urine samples by the iodine azide test (IAT). The results of IAT last determination are presented in Table 5. In 40 per cent of workers IAT index was decreased before work showing the "non-recovery" phenomenon. In the urine samples collected after the end of work IAT values were decreased in 90 per cent of the subjects. Values below 4, showing a high exposure, were found in 45 per cent of examined workers.

TABLE 5
Results of iodine azide test before and at the end of work.

Iodine test	Percentage of subjects		
	Normal	6-4	<4
Before work	60.6	35.0	5.0
At the end of work	10.0	45.0	45.0

CONCLUSION

According to CS₂ determination in air and IAT determination in urine examined workers were exposed to high concentration of CS₂. It is known that long-term exposure to CS₂ might cause neurotoxic effects³.

The EEG recording in newly employed workers at the beginning of exposure showed lower values of DF than in workers with a longer exposure and in invalids. In newly employed workers EEG changes have been established after an exposure of three and four years. These changes manifested themselves in some workers as a shift in DF. The increase in DF between the first and the last recording ranged from 1.5 to 3 cps.

At the beginning of the study the mean μ V value was higher in newly employed workers than in other groups. After four years of exposure the mean value changed and approached the mean value in workers with a long exposure and in invalids. The absolute μ V value was decreased only in cases in which DF was accelerated.

The obtained results suggest that the exposure to higher concentrations of CS₂ in some workers produces changes in the central nervous system in the sense of acceleration of electro cortical cerebral activity. These changes were manifested by EEG in the form of an increase in the DF of background activity and a decrease in the amplitude voltage. Registration of these changes appearing before other clinical signs suggests that the method is useful for early detection of CS₂ effects.

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