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EEG study to HPT in patients with NS pathology using EEG database "EEGHUB.GE"

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Abstract

Nowadays Hyperventilation is a provocation tool used during the electroencephalogram (EEG) registration to detect epileptiform activity. Even in cases where there are no typical manifestations on EEG during hyperventilation, the analysis of the shows a variety of responses, changes, and combinations. EEG data of patients from "EEGHUB.GE" was used. Big Data EEG collected in Georgia have been and integrated and uploaded to the European Open Science Cloud (EOSC). The aim of study is determined the pattern to hyperventilation based on time of onset EEG and age of patients 2186 patients, 1139 females and 1047 males aged 3 to 51years was studded. In 1201 patients EEG reaction/response to hyperventilation was within the normal while those with pathological EEG reaction to hyperventilation (PERH) were 985. The patients were split into the following age groups: 3-6, 7-12, 13-18, 19-30, 31-50. Pathological EEG responses revealed of 3 types. During ongoing/current study pathological EEG-reactions to hyperventilation (I, II, and III) has been classified according to two parameters: time of manifestation (first, second, and third minutes) and age (3-6, 7-12, 13-18, 19-30, 31-50, 51and above) of the patient. The results have shown three types of pathological reactions of EEG and detected the time of manifestation – at the first, second and third minutes of hyperventilation: I type reaction on EEG 74.2% $p<0001$; II type reaction in 22.6% and III type reaction in the first minute – in 3.2% patients. The data of patients are valid by age and

type of reaction due to the first type of reaction prevailed in all age categories p<0,002, χ2(10)x(10)2=28.2. The distribution of patients by pathological reaction to Hyperventilation by age: EEG to hyperventilation revealed in 853 patients (86.6%) p <0.0001; χ2(2)=689,791 in the first minute. in in 95 patients (9.6%) p<0.0001 at the second minutes. The prevailed type I reaction on EEG in 64, 2%. II type reaction was in 29. 4%. III type reaction 6.3% patients Types EEG Reaction to Hyperventilation concerning age is not reliable to third minute of Hyperventilation. Three types of EEG reaction to hyperventilation were revealed in all age-groups of patients with various CNS dysfunctions: In all age groups the disorganization of basic EEG rhythm in the first, second and third minutes of hyperventilation. In the first minute of hyperventilation between all types of EEG reaction and age (3-6, 7-12, 13-18, 19-30, 31-50) a significant ratio was revealed, which was not observed in the second and third minutes. EEG-response to hyperventilation based on ages of patients should be taken account for scientific and clinical study.

KEYWORDS: EEG; hyperventilation; GNS disorder; database

Introduction

Hyperventilation testing (HPT) is a relevant and useful test for the study of electroencephalography (EEG). It was used the test for the study of different disorders of the nervous system. [1]. The method was widely spread during several years and was used not only for the diagnosis of epilepsy but for the diagnosis of migraine, narcolepsy, neuropathy, psychopathy, epidemic encephalitis, and other diseases of the nervous system as well The role and importance of hyperventilation for EEG study are much broader. Nowadays Hyperventilation is a provocation tool used during the EEG registration to detect epileptiform activity [2, 3]. The role and importance of hyperventilation during the encephalographic study are much more comprehensive than the provocation of epileptic activity. Even in cases where there are no typical manifestations on EEG during hyperventilation, the analysis of the electroencephalogram shows a variety of responses, changes, and combinations [4]. At the first stage of our study, we described EEG pathological responses on hyperventilation among people with different dysfunctions [5].

There were lack of data concerning the on the response to forced breathing in people with various functional disorders of the Central nervous system (headaches,

epilepsy, attention deficit hyperactivity, fatigue, drowsiness, sleep and attention disorders, unstable blood pressure, encephalopathy, order and others). There are fewer works describing in patients (CNS dysfunctions) concerning their age (3-6, 7-12, 13-18, 19-30, 31-50) and gender). This type of research and analysis/interpretation of the results will be essential and informative for studying brain processes during the development, maturation, and senility of the neural system. The aim of study is determined the EEG pattern to hyperventilation based on time of onset EEG and age of patients.

Materials and Methods

We used EEG data of patients from “EEGHUB.GE”, Big Data EEG online dataset. EEG data collected in Georgia have been uploaded and integrated to the European Open Science Cloud (EOSC) for the first time in Georgia. This database includes EEG data, which has been collected for 15 years, from Beritashvili Center of experimental Biomedicine (IBCEB) , Tbilisi. Georgia. These are data of 4087 patients, from the different age groups that vary from 1 to 75 years old, both men and women. The database consist the normal EEG and also pathological recording of humans EEG with different brain dysfunction (for example: epilepsy, encephalopathy, ADHD and so on). It involves healthy and CNS disorders brainwave electrical activity recording of human, registered with the background activity and functional samples of EEG.

2186 patients, 1139 females and 1047 males aged 3 to 51years, has been chosen from “EEGHUB.GE” based Hyperventilation testing (HPT). They had various functional disorders of the Central nervous system (headaches, fatigue, sleep and attention disorders, unstable blood pressure, encephalopathy, epilepsy, the deficit of attention deficit, and hyperactivity disorder. In 1201 patients EEG reaction/response to hyperventilation was within the normal.

The study was conducted in a screened, soundproof room at a temperature of 22 ° C in a state of calm sleep at one and the same time of the day (11am-1pm). The first EEG recording was carried out with the purpose of estimating the background activity with closed eyes which lasted for 5 minutes, then with open eyes (5min) and again with closed eyes (5min). Hyperventilation lasted for 3 minutes, while breath holding (15-25 sec.) was done after the cessation of hyperventilation. The duration of the duration of EEG recording was 35-40 minutes.

After performing the Fourier transform, the EEG frequency component analysis was done within the following range: delta (0.5-4.0 Hz), theta-1 (4.0-6.0 Hz), theta – 2 (6.0-8.0 Hz), alpha (8.0-13 Hz), beta-(13-24Hz). EEG recordings were performed using 24-32 – channel computer electroencephalograph ”ENCEPHALAN MEDICOM”, with electrode location according to the International System 10-20 amplifier conductivity range 0.5-100 Hz, filtration frequency 50 Hz.

The SPSS 20.0 program of statistical evaluated the validity of results was used. The software package of statistical data processing SPSS 20.0 checked the validity of the obtained data.

Pathological EEG responses revealed in 985 patients were of 3 types: responses of I (disorganization), II (paroxysmal activity), and III (epileptical activity) types. The type I response corresponds to the disorder of basic rhythm without paroxysm. During ongoing/current study pathological EEG-reactions to hyperventilation (I, II, and III) has been classified according to two parameters: time of manifestation (first, second, and third minutes) and age (3-6, 7-12, 13-18, 19-30, 31-50, 51and above) of the patient.

Results

The results have shown:

Distribution of patients by pathological reaction to Hyperventilation by time:

We revealed three types of pathological reactions of EEG and detected the time of manifestation – at the first, second and third minutes of hyperventilation. In the first minute the pathological EEG response to hyperventilation was revealed in 853 participants, that is 86.6% of the survey participants, in second minute – in 95 people (9.6%), and in the third minute – in 37 people (3.8%).

Based on the analysis of data in all groups three type of EEG response to hyperventilation, was identified at the first minute of the study. In general, in all three groups, was revealed a similar trend in the distribution of the response to hyperventilation. In particular, the predominant manifestation was type, i.e. disorganization of the main rhythm $p<0.0001$, which prevailed with type II and III responses.

Table 1. *The manifestation EEG Reaction to Hyperventilation by time: in the first, second and third minute. I type reaction (on EEG (74.2%) in 633 patients (74.2%) p<0001, II type reaction in 193 (22.6%) patients and III type reaction) in the first minute – in 27 (3.2%) patients.*

Time	Reaction type			Significance
	I type response	II type response	III type response	
First minute	74.2%	22.6%	3.2%	$\chi^2(2)= 689,791$, $p<0,0001$
Second minutes	64.2%	29.5%	6.3%	$\chi^2(2)= 48,4$, $p<0,0001$
Third minute	70.3%	21.6%	8.1%	$\chi^2(2)= 23,73$, $p<0,0001$

The distribution of patients by pathological reaction to Hyperventilation by age:

The patients were divided by EEG reaction type into the following age groups: 3-6, 7-12, 13-18, 19-30, 31-50. The data of patients are valid by age and type of reaction due to the first type of reaction prevailed in all age categories To do this p<0,002 , $\chi 2(10)x(10)^2=28.2$

EEG to hyperventilation revealed in 853 partients (86.6%) p<0.0001; $\chi^2(2)=689,791$ in the first minute .The results shown I type reaction on EEG in 633 patients (74.2%) p<0001; $\chi^2(2)\chi(2)^2$ = 689. 8, II type reaction – in 193 (22.6%) patients and III type reaction in the first minute – in 27 (3.2%) patients.

EEG reaction to hyperventilation revealed in 95 partients (9.6%) p< 0.0001; $\chi^2(2)$ $\chi(2)^2=48.4$ at the second minute. The prevailed type I reaction on EEG) in 61 partients (64, 2%). II type reaction was in 28 patients (29 4%). III type reaction was in 6 (6.3%) patients).

Types EEG Reaction to Hyperventilation concerning age is not reliable to third minute of Hyperventilation.

EEG to hyperventilation revealed in 37 patients (3.8%) $p < 0.0001$; $\chi^2(2)= 689,791$ in the third minutes. EEG reaction revealed in 26 patients (70, 3%), II type reaction – in 8 patients (21.6%), III type of reaction – in 3 (8, 1%), $\chi^2(2)= 23,73$, p<0,0001. Disorganization of basic rhythm to the hyperventilation has revealed.

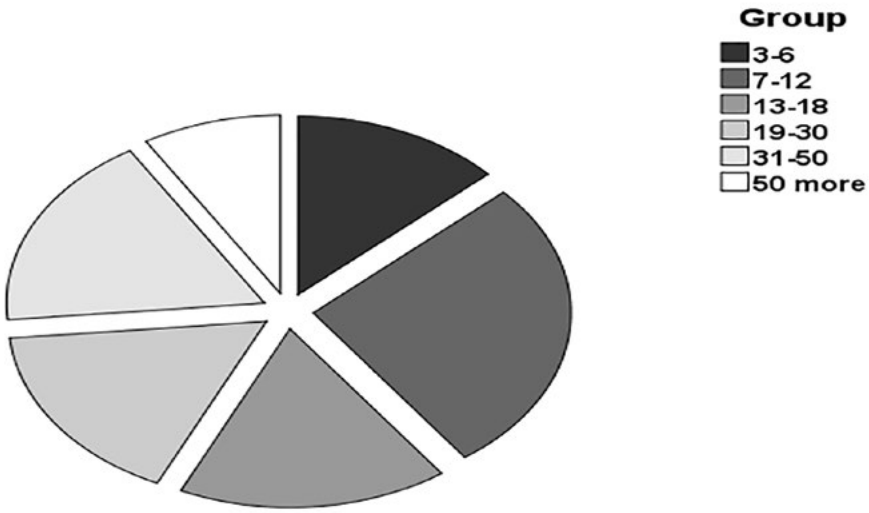

Fig. 1. The distribution of the types of EEG reaction by the time of EEG reaction and age was not reliable.

Discussion

The forced breathing test is one of the most important tests for the identification, study and analysis of brain dysfunction in humans. The results of the current study have shown three types of the pathological EEG response to hyperventilation. Different types of abnormal (pathologic) EEG reactions to hyperventilation is subject for the interpretation [4]. There is an assumption that the cause of the development of slow waves is the impairment of cerebral circulation due to hypocapnia (reduced carbon dioxide in the blood) and associated acute alkalosis [6] which results in insufficient oxygen and glucose supply to the brain. At the first stage of our study, we described pathological EEG-reactions on hyperventilation among people with different CNS dysfunctions (headache, fatigue, drowsiness\sleep disorders, encephalopathy, epilepsy, ADHD etc.). During ongoing study pathological EEG-reactions to hyperventilation has been classified according to two parameters: time of manifestation and age of the patient. One of the factors that determines CNS sensitivity to hyperventilation based on the age of the subjects [7,8]. On the basis of observations of EEG activity, it is known that healthy children up to 12 years of age are particularly sensitive to hypokapnia in response to hyperventilation [6]. At the first stage of our study we described pathological EEG-reactions on hyperventilation among patients with functional disorders of the CNS. We revealed three types

of pathological reactions of EEG and detected the time of manifestation – at the first, second and third minutes of hyperventilation. During recent study pathological EEG-reactions to hyperventilation has been classified according to two parameters: time of manifestation and age (3-6, 7-12, 13-18, 19-30, 31-50) of the patient. In all three minutes, similar tendency of EEG distribution has been identify in response of hyperventilation. On the EEG of all age group in response to hyperventilation was revealed predominate of disorganization of basic rhythm (first type of reaction) which prevailed over the second (paroxysmal activity) and third types (epileptiform activity). The data obtained in the first minute were reliable by age and type of patients' EEG-responses, due to the first type of reaction was predominated in all age group. Such type of reliability was not revealed at the second and third minutes to hyperventilation. It might be noted that the time and degree of detection of pathological EEG reaction the functional load can be related to individual characteristics of investigated patients [9,10]. The 3 main types of PERH found in all age groups of patients can be informative for correct diagnosis, monitoring of treatment plans and functional results. The EEG reaction to hyperventilation undergoes permanent changes during brain maturation and development. Point out that children, adults, and elderly have different individual sensitivity to hypocapnia developed during hyperventilation. Additional factor-gender, provide more information about correlation of EEG – reaction and age that is object of research consideration [11].

Conclusion

Three types of EEG reaction to hyperventilation were revealed in all age-groups of patients with various CNS dysfunctions: In all age groups the disorganization of basic EEG rhythm in the first, second and third minutes of hyperventilation was detected. In the first minute of hyperventilation between all types of EEG reaction and age (3-6, 7-12, 13-18, 19-30, 31-50) a significant ratio was revealed, which was not observed in the second and third minutes. EEG-response to hyperventilation based on ages of patients should be taken account for scientific and clinical study.

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