

The influence of sleep disorders on cognitive functions of a brain at patients with Type 2 diabetes

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ABSTRACT

Aim: The results of neuropsychological and sleep examination with the use of validated tests and questionnaires at 136 patients with the verified Type 2 diabetes mellitus diagnosis are presented in this article. The average age of the examined patients was 59.19 ± 5.649 . The patients were in decompensated condition on indicators of carbohydrate metabolism. **Materials and Methods:** A total of 136 patients older than 40 years with clinically and laboratory proved Type 2 diabetes were examined. The research included the participants of both genders living in Astana with a different national and ethnic origin to be convinced that the research advantage and burden are distributed evenly. Results and Discussion. By results of neuropsychological testing, cognitive functions of a brain were reduced in all age groups at patients with Type 2 diabetes and were characterized by retardation of intellectual activity rate, the reduction of speech fluency, the depression of concentration of attention, memory disturbances of dynamic character. 77.9% of patients had sleep disorders, including, mild degree - 28% of patients; moderate - 30.9% of patients. **Conclusion:** The intrasomnic disorders including frequent night awakenings with the subsequent difficulty of sleep initiation prevailed. It is revealed that insomnia negatively influences on such cognitive functions of a brain as attention and visual-constructive skills.

KEY WORDS: Cognitive disturbances, Epworth sleepiness scale (ESS), Glycated hemoglobin HbA1c (%), Insomnia severity index, Insomnia, Montreal cognitive assessment test, Pittsburg sleep quality index, Type 2 diabetes

INTRODUCTION

The diabetes mellitus (DM) has a significant burden on national health systems of many countries of the world. According to the latest data, published by the WHO about 347 million people around the world suffer from DM from which 90% have Type 2. It is known that the DM – the complicated dysmetabolic disease which is characterized by big prevalence of cerebral vascular pathology which is morphological substrate of cognitive disorders. According to authors, the prevalence of moderate cognitive disturbances (CD) at Type 2 diabetes makes 20% among men and 18% among women of 60 years and older and exceeds the prevalence of moderate CD in population (10–15%).^[1-3] According to researchers, the pathophysiology of the CD at Type 2 diabetes is based on change of the structurally functional relations in a brain occurring in process, more accelerated natural aging.^[4] At patients with a DM decrease of the rate of psychomotor reactions^[5] is observed, executive functions^[5-7] suffer, verbal memory is reduced, rate of obtained information processing^[8] is reduced, and the attention is reduced.^[9]

The connection of DM and CD is mediated by a number of the processes including chronic hyperglycemia, vascular changes, in particular, the angiopathy leading to the disturbance of cerebral blood flow and neurotrophic providing, neuromodulator changes bound with insulin dysfunction and its receptors in a brain.

At the same time, clinical trials showed that up to one-third of patients with DM, have a sleep disorder.^[10] Results of researchers of the past years showed that <6 h sleep duration is associated with the development of resistance to insulin and augmentation of risk in development of Type 2 DM in further.^[11-13]

MATERIALS AND METHODS

A total of 136 patients older than 40 years with clinically and laboratory proved Type 2 diabetes were examined. The research included the participants of both genders living in Astana with a different national and ethnic origin to be convinced that the research advantage and burden are distributed evenly.

Neuropsychological testing is held with the use of validated tests (The montreal cognitive assessment [MoCA]). By this scale, visual-constructive and executive skill, memory, attention, speech, including

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speech fluency, thinking, and space and time orientation were estimated.^[14] For identification of insomnia, the scales and questionnaires recommended by Clinical Guideline for the Evaluation and Management of Chronic Insomnia in Adults, 2008, were used (Pittsburg sleep quality index (PSQI), insomnia severity index (ISI), Epworth sleepiness scale (ESS), the Spielberger state-trait anxiety inventory (STAI), and the Beck depression inventory (BDI).

1. The scale of the PSQI consists of seven components allowing to estimate for the last month subjective value of sleep quality, latency for sleeping, duration and efficiency of sleep, intrasomnic disturbances, somnolent drugs use and day activity disturbances. The score of components exceeding 5 points is regarded as an insomnia.
2. The ISI consists of seven components allowing to estimate current that is for the last 2 weeks sleep problems. The sum of results, corresponding to 0–7 points is regarded as normal, the sum of 8–14 points - mild sleep disorders, the sum of 15–21 points, respectively, as moderate sleep disorders and the sum of 22–28 points as the expressed sleep disorders.
3. ESS allows to estimate day drowsiness and consists of seven components. The sum of results, corresponding 10 points and more is regarded as a pathological sleepiness, 6–10 points - moderate sleepiness, the sum of no more than 5 points as normal.
4. The STAI, the Spielberger test consists of 20 statements relating to anxiety as a state (anxiety condition, reactive, or situational anxiety) and from 20 statements on anxiety definition as disposition, personal feature (anxiety trait). The anxiety level up to 30 points is considered as low, from 30 to 45 points - moderate, from 46 points and above - high. The minimum assessment on each scale - 20 points, maximum - 80 points.
5. The BDI includes 21 categories of symptoms and complaints. To each category, there are 4–5 corresponding statements to which values from 1 to 3 depending on the importance of this statement for severity assessment of depression are appropriated. The maximum point on a scale corresponds to 63, minimum - to 0. The questionnaire's reliability and validity are confirmed in numerous studies. The total point on all categories is considered when interpreting data. 0–9 - absence of depressive symptoms; 10–15 - mild depression (subdepression); 16–19 - moderate depression; 20–29 - the expressed (moderately severe) depression; and 30–63 - severe depression.

Statistical Analyses

Statistical data processing of the results of conducted study is done by SPSS Statistics 10 program.

Qualitative characteristics are described by absolute and relative (%) values. Quantitative characteristics are as an arithmetic average \pm standard error ($M \pm m$). The statistical importance of differences between groups will be determined by Mann–Whitney method, for carrying out the correlation analysis Pearson's correlation will be used.

RESULTS

The general characteristic of the studied group is presented in the Tables 1–3

Women prevailed on gender structure - 89 (65%). The average age of examined was 58.97 ± 5.884 . The average disease duration was 10.29 ± 7.423 years. The average level of glycated hemoglobin (HbA1c) was 9.92 ± 2.602 . 40 (29.9%) patients with Type 2 DM noted that they used medicines for sleep initiation.

Cognitive functions have been reduced by results of neuropsychological testing (MoCA). Furthermore, visual-constructive skills have been reduced, at the same time, executive skills remain and begin to decrease with increase in age. The patients with Type 2 diabetes have coped with the “the naming of objects” test. Investigating attention function, we have revealed that changes of the “Attention” function in a varying degree are found in all patients with Type 2 diabetes. As for the speech activity test, it should be noted that the results have been reduced in all patients. Difficulties in carrying out of abstract concepts are established in 25% of patients with Type 2 DM. It should be noted that the test results “the delayed reproduction” have been reduced, in general, after an interference patients could reproduce 2–3 subjects from five earlier offered. The patients with Type 2 diabetes, in general, remained orientation in space and time.

The frequency of insomnia occurrence at patients with Type 2 diabetes by results of PSQI n (%).

By results of PSQI, the insomnia meets in 77.9% of cases.

Estimating subjective value of sleep quality, it should be noted that more than a half of patients with Type 2

Table 1: The general characteristic of the studied group

Characteristics	No. (%) or means \pm SD
Number of patients	136
Age	58.97 ± 5.884
Sex (female/male)	89/47 (65/34.3%)
Duration of diabetes	10.29 ± 7.423
HbA1c (%)	9.9260 ± 2.602
Hypertension	90 (65.7%)
Ischemic heart disease	1 (7%)
Hypertension+ischemic heart disease	22 (16.1%)

SD: Standard deviation

Table 2: The general characteristic of the studied group

Characteristics	No. (%) or means±SD
Number of patients	136
MoCA (<i>n</i> =26–30)	19.26±3.584
Visuoconstructional skills (<i>n</i> =3)	1.89±0.814
Naming (<i>n</i> =3)	2.92±0.405
Attention (<i>n</i> =6)	4.02±1.226
Language (<i>n</i> =3)	1.15±0.830
Abstraction (<i>n</i> =2)	1.28±0.767
Delayed recall (<i>n</i> =5)	1.82±1.560
Orientation (<i>n</i> =6)	5.76±0.672
BDI	12.31±8.016
Situational anxiety scale	30.81±9.205
Personal anxiety scale	46.12±6.778
ISI	13.25±7.699
ESS	5.38±3.010
PSQI	10.8088±5.0251
Subjective sleep quality (0=very good; 1=fairly good; 2=fairly bad; 3=very bad)	1.79±0.799
Sleep latency (≤15 min=0; 16–30 min=1; 31–60 min=2; ≥60 min=3)	2.08±1.075
Sleep duration (≥7=0; 6–7=1; 5–6=2; ≤5=3)	1.76±1.085
Habitual sleep efficiency (≥85%=0; 75–84%=1; 65–74%=2; ≤65%=3)	1.31±1.183
Sleep disturbances	1.76±0.712
Use of sleeping medication	0.49±0.852
Daytime dysfunction	1.63±1.039

BDI: Beck depression inventory, ISI: Insomnia severity index, ESS: Epworth sleepiness scale, PSQI: Pittsburgh sleep quality index, SD: Standard deviation

Table 3: The general characteristic of the studied group

n	The sum of components up to 5 points	The sum of components over 5 points
136	29 (22.1)	107 (77.9)

diabetes in different age groups estimated there sleep as “rather bad” or “very bad.” The patients with Type 2 diabetes generally noted that they experienced difficulties with sleep initiation from 30 min up to 60 min and more. The sleep efficiency was reduced at patients with Type 2 diabetes. In structure of sleep disorders, the disturbances connected with sleep maintenance prevailed; the patients noted that they had a superficial sleep with easy awakening with the subsequent difficulty of repeated sleep initiation. The patients with Type 2 diabetes noted day activities disturbances from mild to the expressed degree.

By results of ISI mild (38 [28%] patients) and moderated (40 [30.9%] patients), sleep disorders prevailed the average ISI value - 13.25 ± 7.699. The degree of expressiveness of sleep disorders accrued with increase in age.

By results of ESS pathological day, drowsiness was revealed at 3 (4.4%) patients and moderate day

drowsiness was observed at 60 (42.3%) patients. The average ESS value was 5.38 ± 3.010. Estimating anxiety level by results of the STAI 88 patients (64.7%) had a low situational anxiety, moderate at 33 (24.3%), and high at 14 (11%) patients. At the same time, indicators of personal anxiety were low at 1 (0.7%), moderate at 45 (33.1%), and high at 90 (66.2%) patients.

The average value of BDI results was 12.31 ± 8.016. The symptoms of depression were absent at 53 (39%) patients, at 83 (61%) patients, there were depression symptoms from mild to serious degree, in our observation mainly mild and moderate expression degree (61 [44.8%]) were present.

DISCUSSION

Exception Criteria

Existence of the serious or unstable accompanying somatic pathology; previous strokes and transient ischemic attacks, craniocerebral injuries, central nervous system (CNS) tumors, and CNS diseases (inflammatory, degenerative, epilepsy, and cerebral palsy); mental disorders, depression, dementia, alcohol abuse, and narcomania.

Cognitive functions by results of neuropsychological testing (MoCA) in all age groups were reduced. Visual-constructive skills were reduced in all age groups that show fairly expressed cognitive dysfunction connected with frontal lobes dysfunction. At the same time, the executive skills remain and begin to decrease with increase in age. The patients with Type 2 diabetes in all age groups coped with the “naming of objects” test. Researching attention function, we revealed that various degree changes of the attention function are found in patients with Type 2 diabetes in all age groups. As for the speech activity test, it is worth marking that the results were reduced in all patients, as a rule, due to phonetic-mediated associations lowering testifying subcortical-frontal dysfunction. Difficulties in carrying out the abstract concepts were set at 25% of patients with Type 2 diabetes and they expressed in inability to carry out the comparative and generalized analysis. It is worth marking that test results “the delayed reproduction” were reduced in all age groups. Considering that the observed patients with Type 2 diabetes with reduced delayed reproduction, saved objects recognition, it is possible to assume subcortical-frontal dysfunction. The patients with Type 2 diabetes, in general, saved orientation in space and time.

We revealed that sleep disorders are very widespread among patients with Type 2 diabetes. It is necessary to mark that studies of phenomena in sleep disorder in patients with Type 2 diabetes, according to literature, are generally focused on respiratory disorders and

“restless legs” syndrome. The prevalence of an insomnia at patients with comorbid somatic diseases increases up to 50–75%.^[15] In our research, more than half of patients with Type 2 diabetes suffer from insomnia - 77.9%. In the previous researches, it is revealed that patients noticed difficulties in sleep maintenance,^[16] in our research in structure of sleep disorders the disturbances connected with sleep maintenance prevailed. The patients marked that they had a superficial sleep with easy awakening and the subsequent difficult repeated sleep initialization.

At the patients suffering from an insomnia decrease of quantity the delta – sleep is noted that can lead to the development of insulin resistance and glucose metabolism disturbance.^[17] In our research when carrying out the correlation analysis, we did not find significant correlation connection between the frequency and expression degree of insomnia disturbances and carbohydrate metabolism indicators (HbA1c).

Direct positive correlation link between HbA1c and disease duration ($r = 0.289$; $P = 0.01$), levels of situational ($r = 0.190$; $P = 0.05$) and personal ($r = 0.178$; $P = 0.05$) anxiety are established. The degree of expression of an insomnia by results of PSQI had positive correlation connection with age ($r = 0.179$; $P = 0.01$), levels of situational ($r = 0.374$; $P = 0.01$), and personal ($r = 0.383$; $P = 0.01$) anxiety, and also indicators of depressive symptoms expression (BDI) - ($r = 0.564$; $P = 0.01$). Negative correlation connection between average values of insomnia expression and such brain cognitive functions as visual-constructive skills ($r = -0.371$; $P = 0.01$) and attention ($r = -0.370$; $P = 0.01$) is established.

We found out that high level of personal anxiety and depression symptoms expression is independent predictors of the development of insomnia in patients with Type 2 diabetes.

CONCLUSIONS

1. Cognitive functions of a brain by results of neuropsychological testing were reduced in all age groups at patients with Type 2 diabetes and are characterized by retardation of intellectual activity rate, reduction of speech fluency, depression of attention concentration, and memory disturbances of dynamic character.
2. By results of testing using a questionnaire (PSQI) and scales (ISI, ESS) recommended by Consensus Guidelines (2008) on a sleep disorder insomnia disturbances meet in more than 50% of cases among Type 2 diabetes patients. The insomnia of mild and moderate expression degree at patients with Type 2 diabetes prevailed.
3. In clinical phenomenology of insomnia presomnic disturbances (latency augmentation for sleeping)

and intrasomnic deviations prevail (difficulties in sleep maintenance, in the form of frequent night awakenings with subsequent difficult repeated sleep initiation).

4. Insomnia negatively influences on cognitive functions of a brain such as attention and visual and constructive skills.

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