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DIFFERENTIAL PECULIARITIES OF BRAIN NEUROIMAGING IN PATIENTS WITH DIABETIC ENCEPHALOPATHY IN DEPENDENCE ON THE TYPE OF BASIC DISEASE

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Summary

Cerebrovascular pathology in diabetic patients is associated with focal and diffuse cerebral lesions. Though structural brain abnormalities are not diabetes-specific, they are indicative of prognostication of developing cerebral blood circulation impairment in diabetics. Since pathogenesis of diabetic encephalopathy and its clinical-diagnostic manifestation depends on the type of diabetes mellitus, present investigation concerns differential peculiarities of diffuse and focal brain abnormalities in patients with diabetic encephalopathy depending on diabetes type. Influenced by the type of basic disease, neuroimaging data of focal brain abnormalities in patients with diabetic encephalopathy require differential diagnostic and therapeutic approach.

Key words: diabetes mellitus, diabetic encephalopathy, structural brain abnormalities, brain ventricles

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The prevalence of diabetes mellitus (DM) world-wide amounts to 240 million patients and it is expected to rise to 330 or even 500 million by the year 2030 [4]. Diabetic encephalopathy (DE), remaining the least studied chronic complication of DM, is considered to be cerebrovascular pathology, associated with focal and diffuse cerebral lesions [1, 2, 5]. Accompanied with metabolic derangements, cerebrovascular abnormalities and repeated severe hypoglycaemic episodes, kethoacidotic conditions have been implicated to create a unique clinical-diagnostic manifestation of DE [7, 9].

Being not diabetes-specific, structural brain abnormalities are indicative of detection of diabetic angiopathy and prognostication of developing cerebral blood circulation impairment [3]. Neuroimaging studies commonly reveal multiple small focal lesions, generally of periventricular localization, frequently followed by cortical atrophy and enlargement of the cerebral ventricles [3, 6, 8, 10-13].

Recent studies have reported an association between these changes and the patients' age [12, 13], severity of diabetes [3], neurological performance [6], and those neurovisual indices correlated with cognitive deficiency degree in DE patients [8, 10, 13]. Furthermore, due to the difference in pathogenesis of DE in various types of DM, further additional investigation is necessary concerning diffuse and focal brain abnormalities depending on diabetes type.

Materials and Methods

Objective of the research was to reveal differential peculiarities of diffuse and focal brain abnormalities in DE patients (42 cases of DE were analyzed) depending on the type of DM. 12 healthy individuals served as control group. Examination of macrostructural brain abnormalities were performed using magnetic resonance imager (MRI) Siemens Magnetom Impakt and computer tomographic (CT) scanner Siemens Somatom-crx.

Results and Discussion

Linear parameters of the brain lateral ventricles were found to undergo the most substantial changes in both type 1 and type 2 diabetic patients with DE (fig.1).

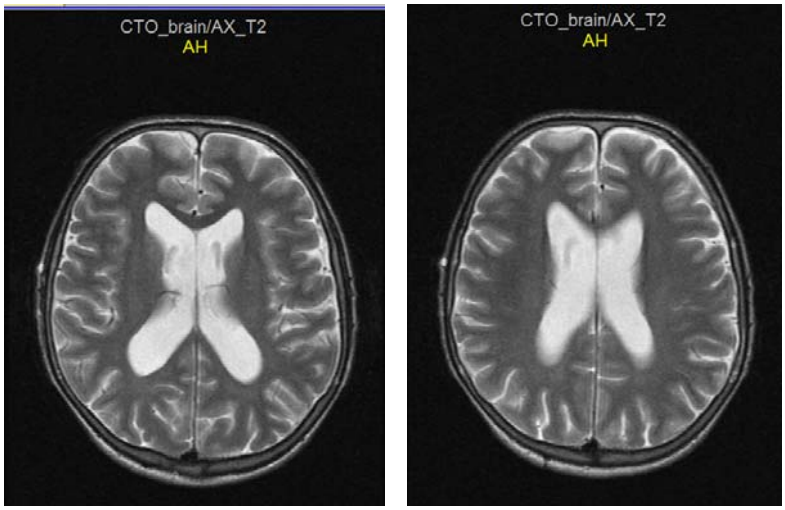

Fig. 1. **Enlargement of the lateral ventricles in patients with diabetic encephalopathy**

Thus, the width of their frontal horns was increased dramatically (Table 1) by 35,9 and 64,1 % in type 1 and 2 DM respectively (high statistical significance was found – P<0,001).

It should be noted, that the most marked extension (by 12,3%, P<0,05) was observed in type 1 diabetes with DE. Significant enlargement of these right-sided parameters was also demonstrated in DM of both types (by 43,5 and 66,1% respectively, P<0,001). The index of the frontal horns of lateral ventricles in type 1 diabetics with DE was 12,3% higher as compared with that in controls (P<0,05). Its increase in type 2 DM was more considerable than in the group of type 1 diabetics (by 13,8%, P<0,05), exceeding that of the controls by 27,8 % (P<0,001).

Absolute transversal sizes of the central regions of lateral ventricles increased in case of DM type 1 (by 45,4% on the left and by 48,6% – on the right, P<0,001) as well as in DM type 2 (by 66,7 and 64,4 % respectively, P<0,001).

Table 1. **Linear parameters and indices of the brain ventricles in patients with diabetic encephalopathy**

Linear parameters and indices of the brain ventricles (mm)	Controls (n=12)	Type 1 diabetics with DE (n=13)	Type 2 diabetics with DE (n=29)
Index of the frontal horns of lateral ventricles	25,2±1,18	28,3±0,94 P_1<0,05	32,2±1,10 P_1<0,001 P_2<0,05
Width of the frontal horns of lateral ventricles, mm			
• on the left	6,4±0,19	8,7±0,43 P_1<0,001	10,5±0,48 P_1<0,001 P_2<0,05
• on the right	6,2±0,21	8,9±0,56 P_1<0,001	10,3±0,42 P_1<0,001 P_2>0,05
Index of the central regions of lateral ventricles	24,6±0,86	27,7±1,08 P_1<0,05	29,6±0,73 P_1<0,001 P_2>0,05
Width of the central regions of lateral ventricles, mm			
• on the left	10,8±0,37	15,7±0,80 P_1<0,001	18,0±0,52 P_1<0,001 P_2<0,05
• on the right	10,7±0,33	15,9±0,83 P_1<0,001	17,7±0,49 P_1<0,001 P_2<0,05
Index of the occipital horns of lateral ventricles	37,0±0,72	41,3±1,28 P_1<0,01	45,7±1,2 P_1<0,001 P_2<0,05
Width of the occipital horns of lateral ventricles, mm			
• on the left	10,2±0,42	13,2±0,93 P_1<0,01	15,1±0,60 P_1<0,001 P_2>0,05
• on the right	9,8±0,42	12,5±0,78 P_1<0,01	14,4±052 P_1<0,001 P_2<0,05
Index of 3rd ventricle	4,2±0,15	6,6±0,36 P_1<0,001	7,4±0,31 P_1<0,001 P_2>0,05
Width of 3rd ventricle, mm	3,9±0,15	6,1±0,40 P_1<0,001	6,9±0,24 P_1<0,001 P_2>0,05
Index of 4^{th} ventricle	13,2±0,44	14,9±0,74 P_1>0,05	15,2±0,52 P_1□0,05 P_2>0,05
Width of 4^{th} ventricle, mm	11,2±0,30	11,2±0,44 P_1>0,05	12,1±0,48 P_1>0,05 P_2>0,05

Note: values are expressed as means ± standard errors;

P_1 – significant difference in comparison with control (P≤0,05);

P_2 – significant difference in comparison between groups of the patients with type 1 and type 2 DM (P≤0,05).

This widening was more significant (P<0,05) in non-insulin-dependent DM than in insulin-dependent one, however the elevation of index of the central regions of lateral ventricles in DE was lower (by 12,6% in type 1 DM, P<0,05, and by 20,3% in type 2 DM, P<0,001) and didn't significantly differ among studied groups. The occipital horns of lateral ventricles in type 1 diabetics with DE were enlarged on the left (by 29,4%, P<0,01) as well as on the right (by 48,4%, P<0,01). In type 2 DM the expansion of these structures was more noticeable (by 48,0 and 46,9% respectively, P<0,001), exceeding the corresponding right-sided index in the group of type 1 diabetics by 15,2% (P<0,05). The occipital horns index also increased concerning the controls in both type 1 (by 11,6%, P<0,01) and type 2 diabetes (by 23,5%, P<0,0001), moreover in case of non-insulin-dependent DM this index was significantly higher than in insulin-dependent DM (by 10,7%, P<0,05). Thus, the signs of internal hydrocephaly were observed in patients with DE, more evident in type 2 DM.

The extension of the subarachnoid spaces in patients with DE was also observed in the present research (fig. 2).

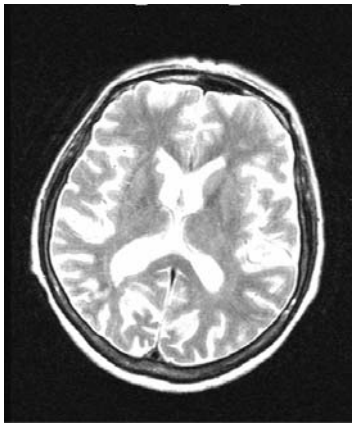

Fig. 2. **Signs of hydrocephaly in patient with diabetic encephalopathy**

The significant enlargement of lateral fissure maximal width (Table 2) was found from its posterior regions on the same level as the pineal body in patients with DE in both type 1 (by 53,5% on the left, by 61,0% – on the right, P<0,001) and type 2 DM (by 69,8% on the left, by 70,7% – on the right, P<0,001). No statistically significant between-group differences were noted.

Maximal width of anterior regions of interhemispheric fissure also increased in case of DE (by 41,0% in type 1 DM (P<0,01) and by 59,0% in type 2 DM (P<0,001)). Central sulcus width also significantly enlarged, although not as markedly as previous parameter (by 18,8% in insulin-dependent DM and by 28,1% in non-insulin-dependent DM).

According to the brain CT scans above the level of lateral ventricles the number of fissures on conveccital surfaces of cerebral hemispheres significantly increased by 21,5% in type 2 diabetics with DE and no statistically significant changes were observed in type 1 diabetics and control individuals.

The extension of ventricular system and subarachnoid spaces in case of DE was indicative of cerebral atrophy. It is obvious, that signs of ventricular hydrocephaly in patients with DE prevailed in comparison with the degree of cortical fissures extension, signifying not only the decreased amount of cerebral white matter in the profound regions of the brain, but also indicating connection with the depression of periventricular tissues resistance towards liquor-dynamic processes.

In addition, the tendency of left-sided prevalence of both external and internal hydrocephaly was noticed.

Table 2. **Subarachnoid spaces ratios in patients with diabetic encephalopathy**

Linear parameters and indices of the brain ventricles (mm)	Controls (n=12)	Type 1 diabetics with DE (n=13)	Type 2 diabetics with DE (n=29)
Sylvian fissure maximal width (from its posterior region), mm			
• on the left	4,3±0,28	6,6±0,46 P_1<0,001	7,3±0,26 P_1<0,001 P_2>0,05
• on the right	4,1±0,26	6,6±0,43 P_1<0,001	7,0±0,25 P_1<0,001 P_2>0,05
Interhemispheric fissure maximal width (from its anterior region), mm	3,9±0,31	5,5±0,37 P_1<0,01	6,2±0,25 P_1<0,001 P_2>0,05
Central sulcus width, mm	3,2±0,17	3,8±0,23 P_1<0,05	4,1±0,18 P_1<0,01 P_2>0,05
Number of fissures above the bodies of lateral ventricles	20,0±0,16	22,3±1,51 P_1>0,05	24,3±0,99 P_1<0,05 P_2>0,05

Note: values are expressed as means ± standard errors;
P_1 – significant difference in comparison with control (P≤0,05);
P_2 – significant difference in comparison between groups of type 1 and type 2 diabetics (P≤0,05).

Significantly more substantial changes of linear parameters and indices of the ventricles in patients with type 2 DM as compared with those in type 1 diabetics reflects more severe cerebral atrophy and internal hydrocephaly in case of non-insulin-dependent DM. Furthermore, the changes of subarachnoid spaces ratios in case of DE tend to be equal in both insulin-dependent and non-insulin-dependent DM.

The investigation of structural peculiarities of the cerebral white matter allowed to detect the focal lesions, mostly left-sided, in 81,0% of patients with DE. The incidence of lesions was equal in DM of both types. Singular or multiple foci, less than 15 mm in diameter, of small lacunar infarctions of the white matter and subcortical ganglia, localized mostly periventricularly, in the areas of small vessels most sensitive to the of hemodymanic disorders, prevailed in neurovisual data of patients with DE (fig.3). At the same time, in type 2 diabetics with DE there were mostly singular, rarely – multiple small lesions, 15 mm in diameter, and in DM type 1 multiple small lesions, sized less than 15 mm, were more frequent. These small spots on MRI scans, related to the expansion of Virchow-Robin perivascular spaces, may be considered as the manifestation of diabetic cerebral microangiopathy. Focal lesions of various localization, sized over 15 mm, were more incidental in insulin-dependent DM as compared with non-insulin-dependent DM (fig. 4). The majority of lesions were located in basal ganglia, thalamus and subcortical white matter, rarely – in cerebral cortex and midbrain. In 69,0% cases of DE, diffuse or focal bilateral white matter lesions of low density of periventricular cortex by CT or high-intensities distributed around the bodies of lateral ventricles (fig. 5) and scored as leukoaraiosis (“periventricular shining”) by T2-weighted MRI were

also observed, being limited in 33,3% cases either by anterior or posterior regions of the ventricles and in 28,6% cases – by anterior as well as posterior ones; in 7,1% cases unlimited periventricular transparency was revealed.

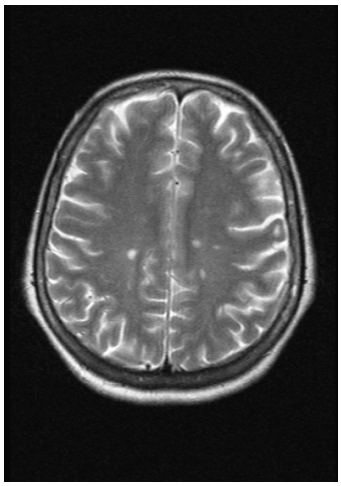

Fig. 3. **Multiple white matter lesions in patient with diabetic encephalopathy**

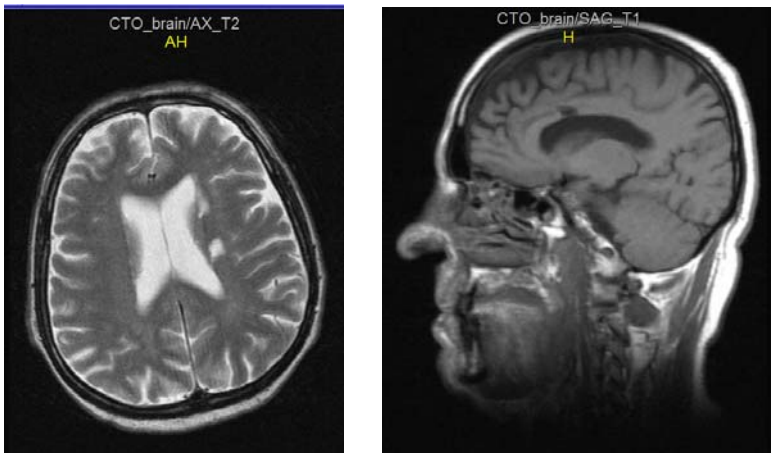

Fig. 4. **Focal white matter lesions, over 15 mm in diameter, in patients with diabetic encephalopathy**

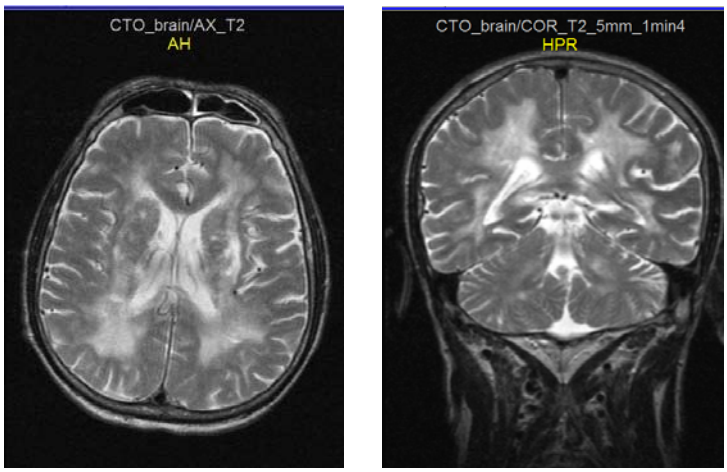

Fig. 5. **Signs of leukoaraiosis in patient with diabetic encephalopathy**

Thus, imaging data of focal brain abnormalities in patients with DE depend on the type of basic disease, indicating to different pathogenical mechanisms of this pathological condition, and require differential diagnostic and therapeutic approach.

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