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Do the asymmetry and the size of the structures of the temporal lobe persist in early stages of schizophrenia?

Joanna M. Moryś[1], Jerzy Dziewiątkowski[1], Barbara Bobek-Billewicz[2], Ilona Ratajczak[1], Olgierd Narkiewicz[1], Janusz Moryś[1]

[1]*Department of Anatomy and Neurobiology, Medical University, Gdańsk, Poland*
[2]*Department of Radiology, Medical University, Gdańsk, Poland*

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A total of 14 patients of various ages diagnosed with schizophrenia and, as an age-matched control group, 12 healthy subjects were examined using the MRI method of neuro-imaging. The volume of the following structures was evaluated in the right and left hemispheres: the superior temporal gyrus, the basolateral temporal area (the region including the middle temporal gyrus, inferior temporal gyrus and fusiform gyrus), the parahippocampal gyrus, the hippocampal head, the amygdaloid body and the inferior horn of the lateral ventricle.
In schizophrenia a significant increase in the volume of the amygdaloid body on both the left and right sides was observed. In the patients, as in the control group, we noticed significant asymmetry between the left and right sides in the volume of the structures studied. The left amygdaloid body was significantly larger than the right, whereas the left hippocampal head and the temporal horn of the lateral ventricle were smaller than the right.
Our findings suggest that in the early stages of schizophrenia, despite the increased volume of the amygdaloid body, the asymmetry between the structures of the temporal lobe is still present. However, the changes observed in the temporal lobe could be related to the functional disturbances observed in this disease.

Key words: magnetic resonance imaging, volumetric study, temporal lobe, schizophrenia

INTRODUCTION

In spite of over 100 years of research, the neuropathology of schizophrenia is still unknown. During past decades there has been great interest in the relationship between the behavioural abnormalities of schizophrenia and brain structure [1, 4–7, 9, 14, 30, 31, 33, 34]. The size of different structures within the temporal lobe has been studied extensively in schizophrenia since 1919, when Kraepelin suggested that the temporal lobe was the seat of the pathophysiology of psychosis [27]. Initially, the studies involved post-mortem examination of brains of persons suffering from schizophrenia. Our purpose was to check whether the volumes of particular structures of the temporal lobe are altered in persons in the first episode of schizophrenia in comparison to the equivalent volumes of an age-matched control.

MATERIAL AND METHODS

The sample included consecutively recruited patients diagnosed with schizophrenia from the Psychiatric Department of the Medical University of Gdańsk. Most of them were in their first episode of

Address for correspondence: Joanna Moryś, Department of Anatomy and Neurobiology, Medical University, ul. Dębinki 1, 80–210 Gdańsk, e-mail: jmorys@amg.gda.pl

illness. The remaining patients had suffered from schizophrenia for no longer than 3 years.

The schizophrenic group consisted of 14 patients aged from 19 to 45 years (mean age: 29.9 years), whereas the control consisted of 12 healthy subjects aged from 21 to 47 years (mean age: 28.4 years). The patients met the ICD-10 [10] criteria for schizophrenia. The control group consisted of healthy volunteers without any neurological symptoms of pathological changes in the central nervous system and without any distinguishable signs on MR scans. All of them were examined using the MRI method of neuro-imaging. MR images of their brains were used for evaluation of the volume of the temporal lobe structures.

MR imaging

MRI was performed on an 0.5T superconducting MRI scanner (Gyroscan T5, Philips) with the use of a standard head coil. In the first step the whole brain was evaluated so as to rule out gross pathology.

The sagittal scout sequence was used to mark a coronal sequence perpendicular to the long axis of the hippocampus (T1W/3D/FFE, TR/TE/FA 30/13/3, Thk/gap 1/0 or 1.5/0, NSA 1).

Stereology

A stereological study was performed on coronal MR images perpendicular to the long axis of the hippocampus by the use of a semi-automatic method on image analyser Q500MC working under software QWin on Pentium 233 MHz with a 17" SVGA monitor.

The following structures were studied within the space bordered by the anterior pole of the amygdaloid body and the posterior pole of the hippocampal head: the superior temporal gyrus (STG), the basolateral temporal area (BTG — the region including the middle temporal gyrus, inferior temporal gyrus and fusiform gyrus), the parahippocampal gyrus (PAH), the hippocampus (HIP), the amygdaloid body (AA) and the lateral ventricle (LV). Delineations of all the structures studied were performed by one member of the group who was highly experienced in neuro-anatomy.

For the evaluation of the volumes of the structures the Cavalieri formula was applied and the coefficient of error (CE) of the evaluation was calculated according to formulae put forward by Geinisman et al. [16]. The sampling was designed to obtain a CE smaller than 3%.

Statistics

For the statistical analysis of the volumetric changes in the temporal lobe structures the appropriate ANOVA procedure was used. The diagnosis of schizophrenia was used as the main factor. The effect of sex was not evaluated. The effect of age was not taken into consideration in view of the lack of significant differences between the groups ($p = 0.83$)

For each structure studied the closeness of fit with normal distribution was checked by means of the Shapiro-Wilk test and the equality of variances by means of Bartlett's test. Analysis of variance was then followed by the post-hoc honest significant difference test (HSD) to study the differences between groups. In the case of non-normality and/or the presence of unequal variances, non-parametric analysis was used.

All calculations were performed on spreadsheets and statistics were drawn up using two packages (Statistica® v. 5.5, Statsoft, USA, and InStat®, StatGraph, USA). For all tests $p < 0.05$ was the level of significance.

RESULTS

Observations were made of the differences between the control and schizophrenic groups in the volume of some structures in the left and right hemispheres. However, the only structure of the temporal lobe whose volume differed significantly between the groups was the amygdaloid body. In patients with schizophrenia the right amygdaloid body was 33.9% and the left 26.6% larger in comparison to their volumes in the control group (Fig. 1).

Asymmetry in volume between the structures in the left and right hemisphere in the schizophrenic group was still present. There was significant asymmetry concerning the amygdala, hippocampal head, superior temporal gyrus, parahippocampal gyrus and the temporal horn of the lateral ventricle. The left amygdaloid body was 3% larger than the right and the left hippocampal head 8%, the superior temporal gyrus 6%, the basolateral temporal area 7% and the parahippocampal gyrus 2% smaller than the right one. In the last one we observed an inversion of differences between the sides, because in the control group the parahippocampal gyrus is larger on the left side (11%) than that on the right. In the group with schizophrenia the left temporal horn of the lateral ventricle was 38% larger than the right one (Fig. 2).

DISCUSSION

In our study the volume of the amygdaloid body was larger among patients with schizophrenia than in patients in the control group. However, in most studies the findings were opposite [3, 7, 13, 15, 25, 28].

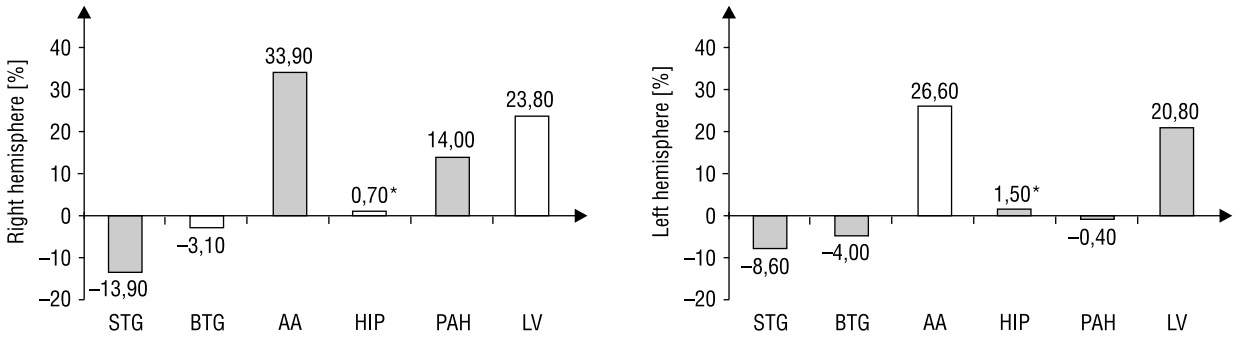

Figure 1. Differences between control and schizophrenic groups in the volume of the structures studied in the right and left hemispheres; TEM — temporal lobe, STG — superior temporal gyrus, BTG — basolateral temporal area (the region including the middle temporal gyrus, inferior temporal gyrus and fusiform gyrus), PAH — parahippocampal gyrus, HIP — hippocampal head, AA — amygdaloid body, LV — temporal horn of the lateral ventricle; *statistical significance $p < 0.05$

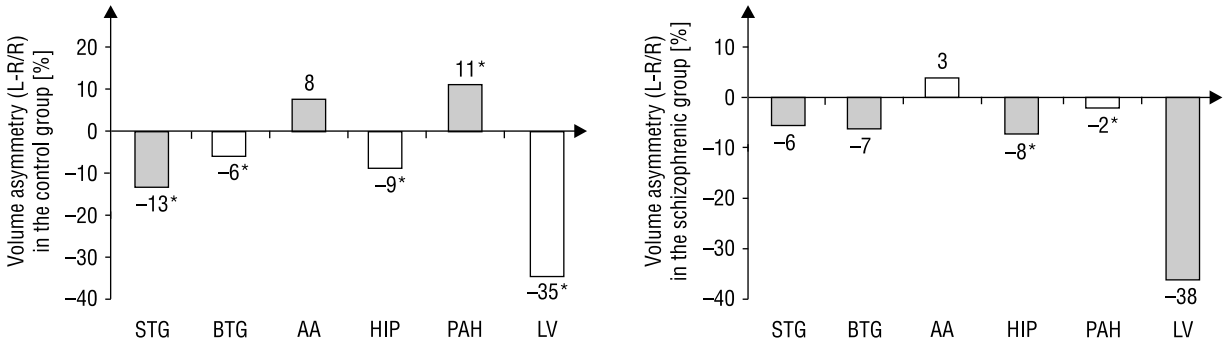

Figure 2. Volume asymmetry of the particular structures of the temporal lobe in the schizophrenic group; TEM — temporal lobe, STG — superior temporal gyrus, BTG — basolateral temporal area (the region including the middle temporal gyrus, inferior temporal gyrus and fusiform gyrus), PAH — parahippocampal gyrus, HIP — hippocampal head, AA — amygdaloid body, LV — temporal horn of the lateral ventricle; *statistical significance $p < 0.05$

Not only was there a decrease in the volume of the amygdaloid body, the volume of the hippocampus was also smaller in the comparison with the control group. A possible reason for this phenomenon can be the fact that reduction in the volume of the amygdaloid body or hippocampus can be correlated with increasing age and a longer duration of illness in chronic patients. In our study the patients were young; moreover, it was either their first episode of schizophrenia or an illness of shorter duration than in other studies. The patients were also in remission phase. The observed volume reduction could also be associated with neurodegeneration [12]. It seems possible that for the above-mentioned reasons we did not observe a reduction in the volume of the amygdaloid body and hippocampus. Some other authors [32] have also reported a reduction in the left hippocampal volume in patients with a history of severe pregnancy or birth complications but no familiar history of schizophrenia.

The first study to investigate brain abnormalities in schizophrenia using CT showed enlargement of the lateral ventricles [18]. In our study we found no significant differences in the size of the temporal horn of the lateral ventricle between the schizophrenic and control group. Other authors have suggested that the enlargement of the lateral ventricles in late stages of schizophrenia can be related to white matter volume reduction [19, 24, 26]. We found that in the schizophrenic group the temporal horn of the left lateral ventricle was significantly larger than the right one. This phenomenon was not observed in the control group.

In the literature there are also studies concerning inter-hemispheric differences in schizophrenia [6, 8, 11, 17, 21]. In our study we observed significant right-left asymmetry in the group with schizophrenia relating to the amygdaloid body, the inferior horn of the lateral ventricle and the head of the hippocampus. The other differences between the structures of the temporal lobe observed in the control group were not significant and according to our observation diminished in the early stage of the schizophrenia. Other authors [29] have found that the volu-

metric differences were limited to the left hemisphere and concerned the amygdalo-hippocampal complex. Additionally McNeil et al. [22] found a correlation between the bilateral decrease in the hippocampal volume and labour and delivery complications in a schizophrenic twin. Some authors found that the volume of the superior temporal gyrus can also be reduced in schizophrenic patients. Barta et al. [2] and Shenton et al. [29] found that this reduction only concerned the left superior temporal gyrus, which can be related to auditory hallucinations. On the other hand, Pearlson et al. [23] reported a smaller left amygdaloid body and right anterior STG in patients with bipolar disorder but not in those with schizophrenia. There are also some suggestions that in the early stages of schizophrenia the reductions in volume of the left STG may be reversible [20]. Shenton et al. [29] also found an interesting correlation with other brain regions. They reported that the reductions in volume of the hippocampus, amygdaloid body, parahippocampal gyrus and STG are highly intercorrelated, which suggests a functional relation.

CONCLUSION

It can be said that in the early stages of schizophrenia a significant increase can be found in the volume of both amygdaloid bodies and some differences in the asymmetry of temporal lobe structures, which could be related to the functional disturbances observed in this disease.

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