



Impairment of cognitive functions in children and adolescents with focal epilepsy

Martyna Domańska^{*}, Marta Zawadzka, Seweryna Konieczna, Maria Mazurkiewicz-Bełdzińska

Department of Developmental Neurology, Medical University of Gdańsk, ul. Dębinki 7, 80-952, Gdańsk, Poland

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ABSTRACT

Introduction: Frontal Lobe Epilepsy (FLE) and Temporal Lobe Epilepsy (TLE) are the two most frequent types of focal epilepsies and they are connected with difficulties in cognitive functioning. Despite multiple trials to systematize profile of cognitive functioning among children with epilepsy by researchers, the available data are ambiguous. The aim of our study was to compare the cognitive function of children upon diagnosis of TLE and FLE and during follow-up and to compare with a control group of healthy children.

Material and methods: Study included 39 patients with newly diagnosed TLE, 24 patients with FLE whose first epileptic seizure occurred between their 6th and 12th year of life and 24 healthy children matched by age, sex and IQ level. Neuropsychological examination was performed the moment of diagnosis and 2–3 years later using diagnostic tools validated and standardized to the patient's age. Intergroup comparison was conducted in both stages of study. Also, correlation between localization of epileptic focus and cognitive difficulties was analysed.

Results: Children with FLE and TLE accomplished worse results in most of the cognitive tasks compared to the control group already in the initial examination. Patients with FLE presented difficulties in memorizing verbal and visual material, attention and in learning new information. Patients with TLE had difficulties in tasks engaging verbal and non-verbal memory and attention. In the follow-up, patients with FLE presented more severe cognitive impairment compared with the other groups. Despite similar tendencies among children with TLE significantly worse results in tasks engaging verbal memory and attention were observed among patients with FLE. It is noteworthy that patients suffering from FLE and TLE present deficits in many aspects of cognitive functioning already at the time of diagnosis.

Conclusion: Children and adolescents suffering from epilepsy are at risk of psychosocial difficulties, emotional disorders and mental illnesses. Thus, full assessment of cognitive function is essential in this patient group not only at the moment of diagnosis but also during follow-up in order to quickly introduce an individual support system.

Abbreviations: FLE, Frontal Lobe Epilepsy; TLE, Temporal Lobe Epilepsy; CNS, Central Nervous System; MRI, magnetic resonance imaging; IQ, intelligence quotient.

^{*} Corresponding author.

E-mail address: martynadomanska@gumed.edu.pl (M. Domańska).

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1. Introduction

Epilepsy is one of the most common chronic disorders of Central Nervous System (CNS). The data with regards to the prevalence of epilepsy in children and teenagers is comparable to the data regarding adults: 0.7–1% of the total population and the incidence proportion stands at about 50–72,000/100,000 children. Among focal epilepsies in children and teenagers, Temporal Lobe Epilepsy (TLE) and Frontal Lobe Epilepsy (FLE) are the most frequent and epilepsies from the parietal and occipital localizations are much more rarely observed [1]. There are many factors which influence the type and intensity of cognitive impairments in patients with epilepsy. These factors include localization of the epileptogenic focus, seizure frequency, age at which first seizure occurred or number of anti-epilepsy drugs. There have been several studies which indicate that early age at onset of seizures is one of the major factors influencing cognitive impairment [2–5]. This is probably related to the reduction of neural connections and difficulties in creating new ones [6]. Childhood is the period of brain maturation and changes in excitatory and inhibitory circuits, therefore epilepsy may interfere with normal cerebral development. In addition, epilepsy in childhood may have more severe effects on the brain structural than during adulthood, as the various difficulties in cognitive function are more often found among children than in adults with epilepsy. This is a consequence of the fact that an epileptic process can influence the cerebral cortex which is still maturing during childhood. The relation between the early onset and reduction in brain connectivity, especially in white matter, was postulated. What is important, this reduction was associated with deterioration in some cognitive areas [7,8].

Although several studies have demonstrated an increased risk of cognitive problems in many types of epilepsies, many of them did not include a complete neuropsychological assessment [2,9–11]. As Matricardi et al. underlined, the extent of cognitive impairment in epilepsy has not been systematically investigated, especially among children [12].

Despite multiple trials to systematize information concerning cognitive functioning in children and adolescents with epilepsy, available data in the literature are incoherent and ambiguous. About half of the patients with newly diagnosed epilepsy demonstrate difficulties in cognition and/or emotions, therefore it is recommended that all patients with newly diagnosed epilepsy have undergone at least screening assessment of the cognitive functioning [13–15]. Such preliminary assessment may indicate whether the patient requires more detailed neuropsychological examination. Currently there are no specific recommendations regarding which neuropsychological tests should be used when examining patients with epilepsy, however we know which basic aspects of functioning which should be assessed [16].

The aim of our study was to compare the cognitive function of children at the moment of diagnosis with TLE and FLE and later during its course and to compare them with a control group of healthy children.

2. Material and methods

2.1. Subjects

39 patients of the Developmental Neurology Department at the Medical University of Gdańsk with TLE and 24 with FLE were included in this study. Children were classified to the TLE group or FLE group according to morphology of their seizures and EEG recordings. The inclusion criteria were: age of the seizure onset (range between 6 and 12 years), normal brain magnetic resonance imaging (MRI) and intelligence quotient (IQ) level higher than 90. Patients with multiple seizure localization, any brain lesions on MRI or other neurological disorders as well as patients with diagnosed other known cognitive impairment which existed before seizure onset were excluded. There were no reports of drug's side effects concerning cognitive or psychomotor functioning during all study. The control group of 24 healthy children were matched accordingly to the age, sex and IQ level of our epilepsy patients. Our control group patients did not have any medical history nor any reported educational and social problems at school. All children participated in this study on the basis of their parents' written informed consent. The Independent Bioethics Committee for Scientific Research at Medical University of Gdańsk approved the study protocol (ethical approval number NKBBN/343/2015).

2.2. Neurological assessment

At the time of diagnosis all patients with epilepsy had MRI scans of the brain and EEG evaluation (usually in 3–6 months intervals). The initial EEG was recorded for 20 min during wakefulness and was performed using the international 10–20 system of electrode placement. Patients were assessed clinically and medical history was collected from their parents at the beginning and at the end of study. Diagnosis of TLE and FLE were based on EEG, semiology of seizures and medical history of patients. All inconclusive cases were excluded from the study.

2.3. Neuropsychological assessment

All children included in our study underwent neuropsychological assessment at the time of diagnosis (Examination 1) and at the end of the study (Examination 2). The time lag between first and second assessment was 2 years. Patients with TLE and FLE were firstly evaluated before including any drug treatment. Each participant went through a neuropsychological examination by means of the age-standardized and validated diagnostic tools. Neuropsychological assessment was performed after 24 h since last seizure, if it occurred. To assess our patients' memory, visuospatial functioning, attention, motor and mental speed the following tests were applied:

- **Key Auditory Verbal Learning Test (RAVLT)** – provides measures of immediate memory, efficiency of verbal learning, effects of interference, and recall following short and long delay periods. It contains 5 trials in which participant listens to 15 unrelated words and is asked to repeat as many words as possible.
- **Benton Visual Retention Test (BVRT)** assesses visual perception, visual memory and visuospatial abilities. It consists of 10 tables including one or few geometrical patterns that patient is asked to remember and reproduce immediately after exposure.
- **Toulouse-Pieron Test** – measures various aspects of attention: concentration, resilience against the distractors, attention span and fatigue.
- **Digit Span** – part of the Wechsler Intelligence Scale for Children – WISC-R (Modified Version) – assesses verbal and working memory as well as effects of interference.
- **Coding** – another part of the WISC-R scale that measures visuospatial coordination, motor and mental speed.

2.4. Statistical analysis

In order to assess distribution of results in examined groups, the Chi-Square test was used for the verification normal distribution, then the Kolmogoroff–Smirnov Test was used, because of the number of the study samples. Because the distribution of the samples was normal, student's t-test was applied, followed by an ANOVA between the groups before and after. A two-factor analysis of the variances for the samples in the mixed configuration was applied to assess the differences in terms of the level of completion of individual tasks. The inter-object factor was represented by the group of patients: control group, patients with FLE and TLE. The intra-object factor was represented by the repetitive measurement by means of the test in the examination 1 and examination 2. The intergroup comparison was conducted at both stages of the examination. The correlation between localization of epileptic focal and the cognitive disorders was also analysed. The significance of all tests was judged at the 0.05 significance level.

3. Results

3.1. The characteristics of the examined group

All groups enrolled in this study were similar in mean age and gender. The median age at seizure onset was 7.8 years in FLE group and 8.2 in TLE group. Table 1 presents studied group characteristics. Magnetic resonance imaging (MRI) showed no brain structural abnormalities in all epilepsy patients. Also the control of the seizures was adequate: patients presented lack or few (1–4) seizures per year. The Test Chi Square analysis for one group showed that groups were statistically equal $\chi^2(2) = 4.56$; $p = 0.102$.

3.2. Results in neuropsychological examination

3.2.1. Benton test results – correct answers

The analysis showed that no matter which examination was carried out, patients from control group and patients with TLE reached significantly higher results than those with FLE. The differences between the groups amounted to 56%. The analysis of the effects of simple interactions showed that the control group had significantly better test results in the second examination (by 18%) than in the first examination. Patients with FLE and TLE had similar results in the second examination to those in the first one. The interaction analysis also showed that patients from the control group and those with TLE had significantly higher results than patients with FLE (these differences amounted to 41%). In first examination as for the results obtained in the second examination, individuals from the control group and patients with TLE had significantly higher results than patients with FLE (43% difference) (Fig. 1).

3.2.2. Benton tests results – incorrect answers

The analysis showed that regardless of the conducted test, patients from the FLE group had lower results than those with TLE and the control group. The differences between the groups were 13%. Patients from control group had significantly higher results in the examination 2 than in the examination 1. There were no significant statistical differences in two other groups (Fig. 2).

3.2.3. Digit span results

The analysis showed that children from the control group in the second examination had significantly higher results (by 23%) than in the first examination. The patients with FLE had significantly lower results (by 4%) than in the first examination (this difference was on the borderline of the statistical significance $p = 0.076$). In group with TLE, the test results in the first examination were significantly higher than in the second examination (the differences were at 23%). The analysis of the interactions also showed that in the first

Table 1
Demographic and medical information for each group.

Characteristics	FLE	TLE	Control group
Age at first seizure/age at first examination	7.8 (6–12)	8.2 (6–12)	7.6 (6–12)
Sex	M/F 1.07	M/F 1.3	M/F 1.1
Handedness	22 R/2 L	35R/4 L	23R/1 L
IQ	102.3 (10.6)	103.4 (11.1)	105.4 (10.2)

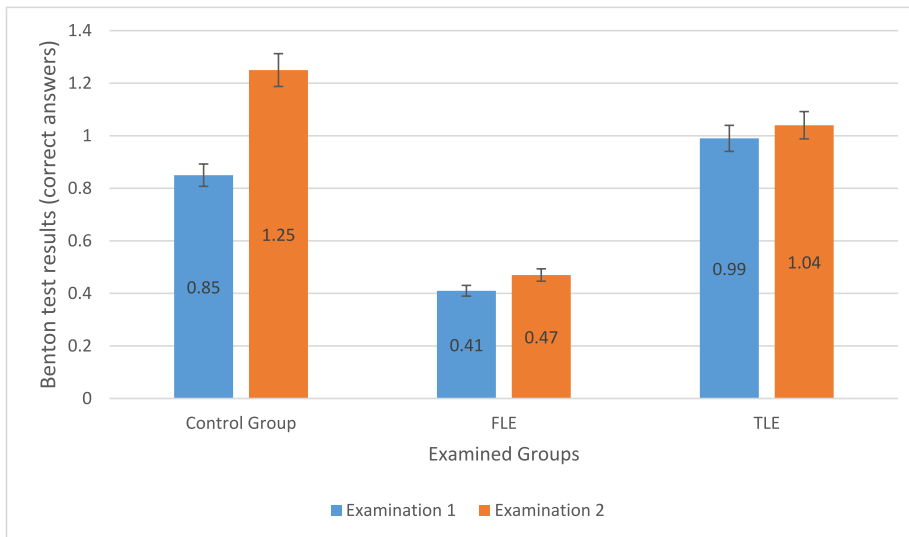


Fig. 1. The differences in Benton test results between the examination 1 and 2 (correct answers). Patients from the control group and those with TLE had significantly higher results than patients with FLE ($p < 0.01$).

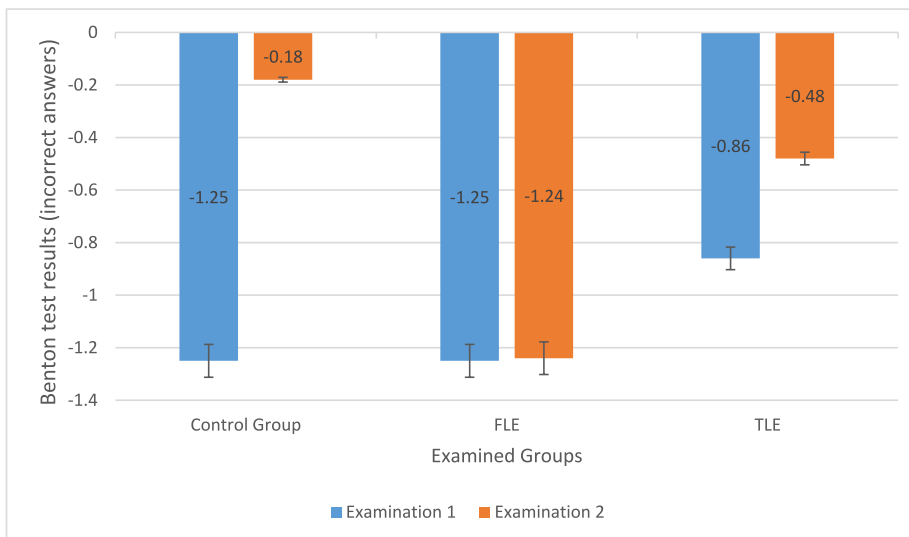


Fig. 2. The differences in Benton test results (incorrect answers) between the examination 1 and 2. Patients from the FLE group had significantly lower results than those with TLE and the control group ($p < 0.01$).

examination, the members of the control group had significantly lower results in the test than patients with FLE and those with TLE (these differences to 18%). Results obtained in the second examination showed that patients from the control group and FLE patients had significantly higher results than those with TLE (the differences amounted to 13%) (Fig. 3).

3.2.4. Coding test results

The analysis showed that regardless of the examination point, patients from control group had higher results in the Coding test than patients with FLE and those with TLE. Differences between the groups amounted to 35%. The analysis of the simple interactions showed that children from control group had similar results in both examinations. Patients with FLE had significantly lower test results (by 27%) in the second examination than in the first examinations. Similar results were observed in patients with TLE, but the differences between examinations were smaller (amounted to 23%). The analysis of the interactions showed that patients from studied groups scored similar results in first examination. Patients from the control group had higher results than patients with FLE and those with TLE in the second examination (differences were at 38%) (Fig. 4).

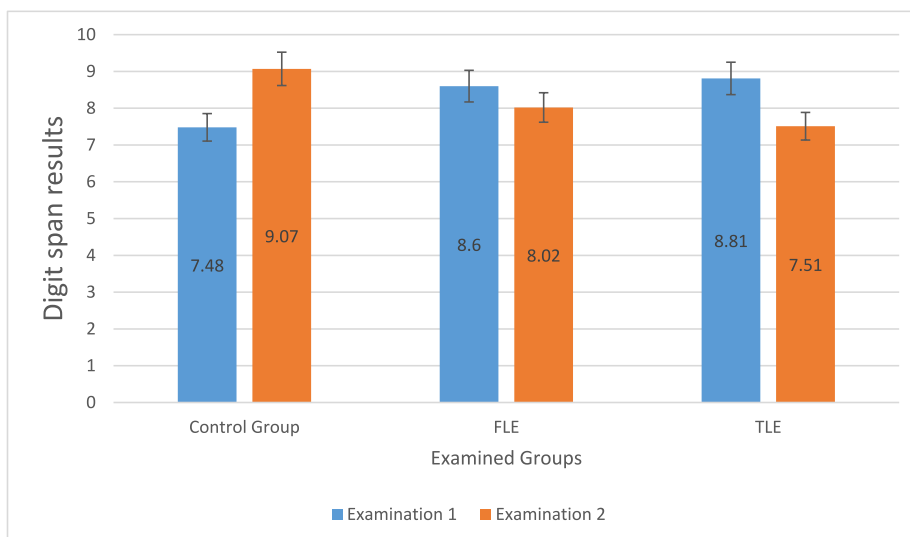


Fig. 3. The differences in Digit span results between the examination 1 and 2 in each group. In the second examination, the control group had significantly lower results in the test than patients with FLE and those with TLE ($p < 0.001$).

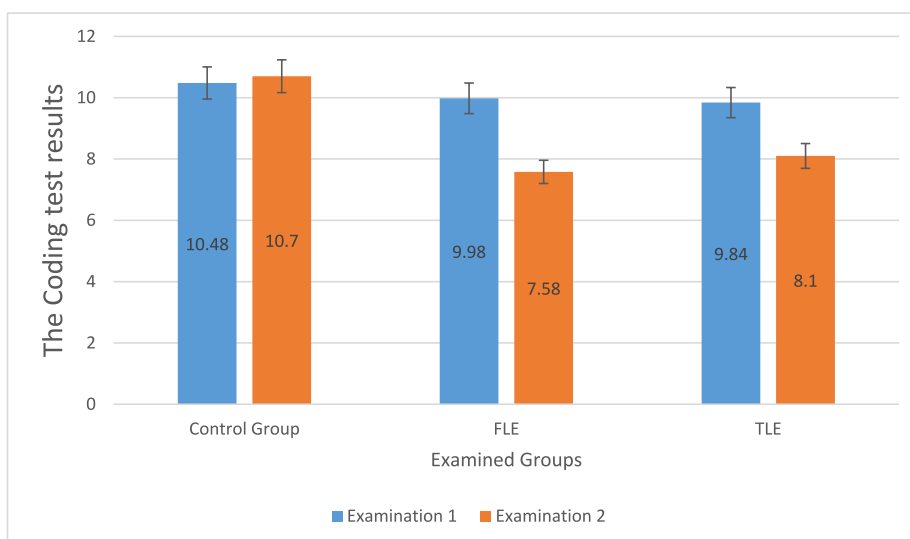


Fig. 4. The differences in Coding test results between the examination 1 and 2 in each group. Patients from the control group had higher results than patients with FLE and those with TLE in the second examination ($p < 0.001$).

3.2.5. The Toulouse-Pierron test results – time of execution

The analysis of the execution time in the Toulouse-Pierron test showed that patients from the control group scored significantly the highest results in test, regardless of examination point. Lower results were scored by patients with TLE and the worst ones by those with FLE. Differences between groups were at 60%. The analysis showed also that patients from control group had similar results in the first and second examination. Patients with FLE had significantly lower test results (by 76%) than in the first examination. A similar pattern of the results was obtained in patients with TLE. Differences (22%) were not distinctive. The analysis of the interactions also showed that patients with FLE had a significantly worse result than those with TLE and individuals from the control group (differences were at 14%) in the first examination. Patients from the control group had the best results in second examination, those with TLE had lower results. The worst ones were scored by FLE patients – (these differences were at 66%) (Fig. 5).

3.2.6. Toulouse Pierron test results – correct answers

The analysis showed that regardless of the examination point, patients from the control group scored significantly higher results in the test than those with TLE and with FLE. Differences between the groups were 26%. The analysis also showed that patients from the control group had similar results in the first and second examination. Patients with FLE scored significantly lower results in the second

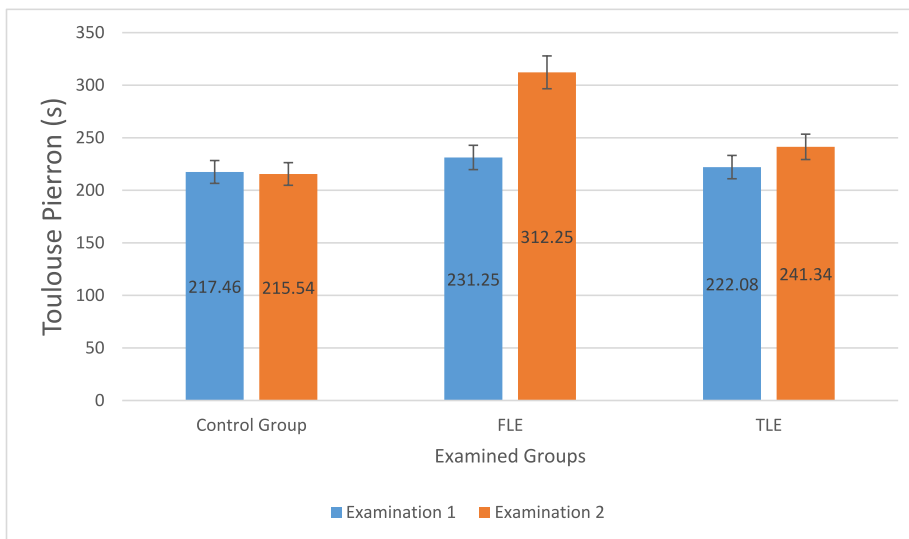


Fig. 5. The differences in the Toulouse Pierron test results (seconds) between the examination 1 and 2 in each group. Patients with FLE had a significantly worse result than those with TLE and patients from the control group ($p < 0.001$).

examination (by 61%) than in the first one. Similar pattern results were obtained in patients with TLE, but differences between examinations were smaller (54%). The analysis of the interactions also showed that patients with FLE scored a significantly lower result than the examined ones with TLE and the ones from control group (difference was 14% in the first examination). Patients from the control group had significantly higher results than patients with TLE and FLE (differences amounted to 48%) in the second examination (Fig. 6).

3.2.7. The results of the RAVLT test

The analysis showed that regardless of the examination point, patients from control group scored the highest results, results of patients with TLE were in the middle the lowest results were scored by patients with FLE. Differences between groups were at 63%. The analysis showed that patients from the control group had significantly higher results in the first examination than in the first one (the difference was 9%). The patients with FLE had significantly lower results in the second examination than in the first one (44%). A similar pattern of the results was obtained in patients with TLE, but the differences were smaller (31%). The analysis of interactions also showed that with regards to the results obtained in the first examination, patients with FLE scored a significantly lower result than those with TLE and children from control group (the differences were 23%). Patients from the control group had the highest results,

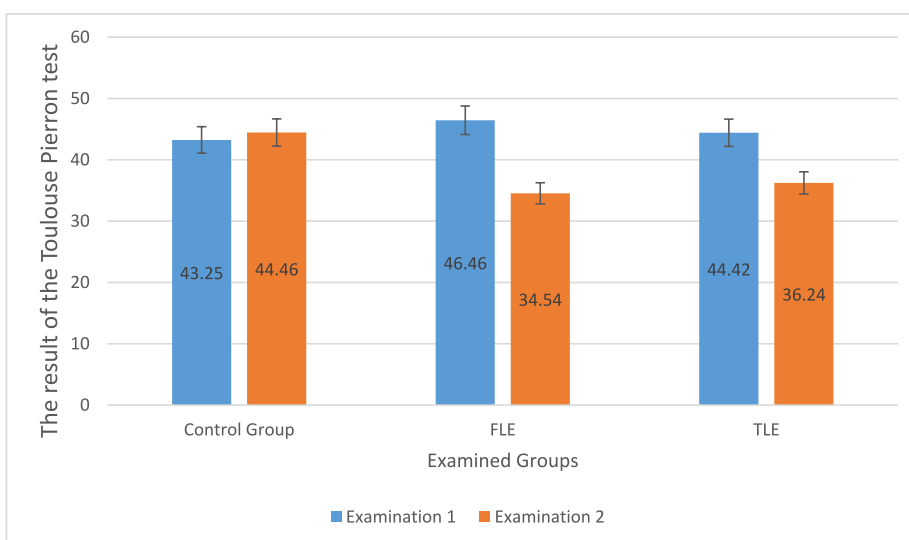


Fig. 6. The differences in the Toulouse Pierron test results (correct answers) between the examination 1 and 2 in each group. Patients from the control group had significantly higher results than patients with TLE and FLE in the second examination ($p < 0.001$).

lower were scored by those with TLE, and the lowest ones were scored by patients with FLE (the differences were at 71%) – the differences were statistically significant (Fig. 7).

3.2.8. The results of RAVLT test – the analysis of the learning curves

The analysis of the learning curves that the worst learning ability was found in the FLE group. The analysis of the learning curves in the second examination showed the worse learning ability in the group of patients with TLE and FLE than in the control group. However, the patients with FLE performed significantly the worst (Figs. 8 and 9).

Children with the focal epilepsy achieved worse results in most of the cognitive tasks comparing with the control group in the first examination. Patients with FLE presented difficulties with memory of verbal, visual material and in attention, as well as in learning new information. Patients with TLE had difficulties in the sentences which involved memory (verbal and non-verbal) and attention. In the long-term analysis, FLE patients presented significantly greater decrease in cognitive functioning than two other groups. Despite the similar tendency among children with TLE, those in the FLE group had the significantly worse results in verbal memory as well as in attention tasks. It seems very important that patients suffering from the focal epilepsies presented the deficits in many aspects of the cognitive functioning already at the time of diagnosis.

4. Discussion

4.1. Memory functioning in patients with focal epilepsy

The results we obtained show that patients with FLE as well as those with TLE have worse level of visual memory functioning while comparing them with control group. The clear difference can be seen while comparing patients with FLE and the examined two remaining groups. In the second examination, patients from the control group achieved significantly higher results than in the first examination, while the results patients with the diagnosed epilepsy did not change significantly.

In the examination of verbal memory, patients from control group scored significantly higher results than patients with FLE and TLE. Results achieved in the second examination by control group were better, those by two other groups – lower. This indicates the deterioration of the verbal memory in the course of the disease, especially among patients with FLE, who had greater decline than patients with TLE. These results seem to be consistent with the data from literature [12,17–19]. In their study of 71 children with the diagnosed FLE at the age of 6–16, Braakman et al. showed that in tasks engaging memory, patients with epilepsy achieved results significantly below the norm [20]. One of tests used in this examination was the German version of AVLT, the same which was used in our research. The most significant problems were observed in memorizing new information, in trial which involved recalling, the results were slightly better. The key limitation of the study by Braakman et al. is the comparison of results to the current norms, rather than a control group. Memory disorders were also described in the course of TLE [21–26].

Nolan et al. published one of the few studies which compared the memory function of the patients with FLE and TLE [26]. Results of the neuropsychological examination using WRAML indicated the significantly worst execution in patients from TLE group with regards to verbal memory and in some tasks involving visual memory. Children from the FLE group presented lower results in some tasks, but at the same time performed globally better than the children with TLE. Correlation analysis which was carried out by authors also indicates the following relation: the longer duration of illness, the worse memory function.

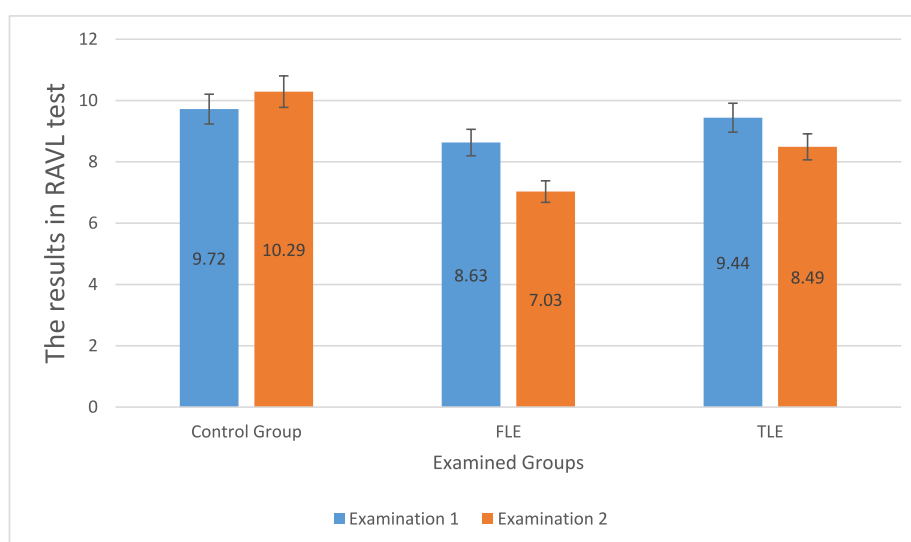


Fig. 7. The differences in RAVLT test results between the examination 1 and 2 in each group. Patients from the control group had the highest results, lower were scored by those with TLE, and the lowest ones were scored by patients with FLE ($p < 0.001$).

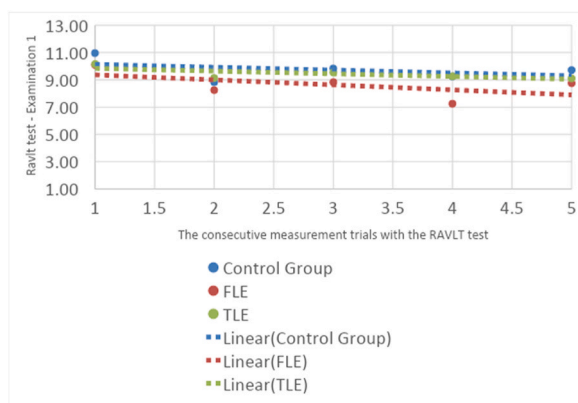


Fig. 8. The course of the consecutive trials carried out in the RAVLT test in the first examination.

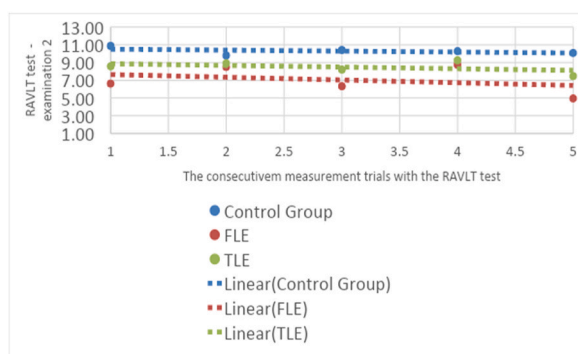


Fig. 9. The course of consecutive trials carried out in the RAVLT test in the second examination. The patients with FLE performed significantly the worst.

Various aspects of memory were taken into the account in the literature concerning epileptic patients. Children with TLE seem to have the greatest difficulties in recalling the material, whereas patients with frontal seizures demonstrated bigger problems when organising the presented material and choosing the memorizing strategy [19,27,28]. The results obtained in our study indicates visible difficulties in TLE and FLE group. At the same time, children with FLE had the worst results – difficulties concerned reproduction of previously presented material.

Results of patients with FLE and TLE in tasks involving verbal memory are also coherent with information provided by literature [19,29]. The researchers in their works emphasized that memory deficits of verbal material are not present, as it seemed before, only in patients with the TLE but also among children with FLE. The researchers claim that the difficulties demonstrated by children with FLE can be explained as a result from deficits in the executive function which are very common in this group of patients [30]. Taking into consideration the fact that memory function can be a part of more extensive disorder, it should be considered whether memory functioning does not include other cognitive functions such as attention, language and executive functions.

4.2. Attention in patients with focal epilepsy

In our study, patients with FLE and TLE presented worse execution than the children from the control group. Moreover, this tendency was stronger in patients with longer duration of illness. Results in control group concerning execution time and number of correct answers were similar in the second examination. Different tendency was observed in children with diagnosed epilepsy where second examination results were worse. This tendency was the most visible among patients with FLE. It means that ability to concentrate and maintain attention were on lower level among children with epilepsy than in healthy children.

Difficulties in attention functioning among patients with newly diagnosed epilepsy were shown in previous studies [31,32]. It was proved that this group has significantly worse results in tasks which involved selective attention and ability to maintain attention. Culhane-Shelburne et al. published one of the few comparisons of attention functioning in patients with frontal seizures epilepsy and the temporal seizures epilepsy [33]. The researchers did not find any significant difference between the examined groups in various aspects of attention such as impulsiveness or difficulties with keeping attention. At the same time, obtained results were significantly below the norm in both groups – same as in our research. There was no reference to the control group in Culhane-Shelburne's research. Researchers also emphasize significant limitations of the conducted studies on the cognitive functions in children with the focal

epilepsy – small number of intergroup comparisons and rare studies with repeated assessments.

In the study by Hernandez et al. [28], children with epilepsy presented difficulties in tasks involving attention. Authors pointed out that execution in group with the FLE was worse than in TLE group, mainly in tasks which required maintaining attention. In task which involving attention of verbal material, groups with frontal and temporal seizures reached results below the norms. Results presented by Hernandez et al. indicate a similar tendency to one presented in our study: attention functioning is more deteriorated in both epilepsy groups than among healthy children, whereas the patients with FLE had the greatest difficulties in this area.

4.3. Working memory in patients with the focal epilepsy

Children from the control group scored worse results in the first examination than the patients with diagnosed epilepsy in tests assessing working memory. However, results were completely different in the second examination, where healthy children achieved significantly better results than in the first examination. Whereas the patients with epilepsy achieved worse results than in the first examination. This seems to suggest that the working memory function worsens during the illness among patients with the FLE as well as with TLE.

In many articles, working memory is often described as a part of executive functions [9,28,34], Authors indicate that epilepsy influences working memory with regard to both: verbal and visuospatial material[35]. In many articles epilepsy type was not taken into consideration. The aim of those studies was to determine the general tendency among children suffering from epilepsy.

Observations made by Brackman et al. [20,33] Hernandez et al. [28] and Rzezak et al. [36,37] are similar to those presented in our work. These authors showed visible problems with working memory in course of TLE and FLE.

Results presented in the literature as well as those from our work can be explained by the fact that the prefrontal cortex is involved in activities necessary for the correct functioning of working memory e.g. monitoring, active extraction and manipulation of the information [38,39,40,]. Patients with TLE are described as those who have decreased volume of white matter near thalamus, hippocampus and caudate nucleus while comparing to healthy people [41,42]. This has an impact on disfunctions in cortical and subcortical areas which are crucial for working memory. Moreover, the temporal lobes are strongly linked in frontal lobes by numerous neural connections [43,44]. Seizure activity spread from the temporal to frontal areas through neural connections is described as one of the most important mechanisms that affect working memory in patients with TLE [7,45].

4.4. Learning curve in patients with focal epilepsy

The analysis of learning curves indicates significant problems among patients with FLE already at the onset of illness. Results of the second examination indicate worse execution in both groups of patients with diagnosed epilepsy compared to the healthy children. This difference was most visible among the children with FLE. It is noteworthy that results in second assessment were significantly lower than in the first measurement in patients with epilepsy, while they remained similar in the control group. It can be explained by the fact that focal epilepsy has influenced on processes of acquiring new information. Hernandez et al. analysed verbal learning using similar method as it we did - California Verbal Learning Test (CVLT) [28]. It is worth to emphasize that despite the differences between the AVLT test used in our work and the previously mentioned CVLT, the results appear very similar, the ability to learn was distinctively disturbed in children with FLE, whereas patients with TLE presented worse results compared to the control group. Regardless which neuropsychological test was used, results in examined groups look the same. This is a result of distinct differences in the learning process of children with focal epilepsy and healthy ones.

The analysis of learning curve seems to be very clinically significant. Children and adolescents suffering from focal epilepsy, especially with good control of the seizures, can make progress in learning at school, without additional support from teachers or family. Despite that, as noticed by Aldenkamp et al., about 50% of the children with epilepsy (including focal epilepsies) present difficulties with learning [46]. Mojs et al. reported in her work that up to 37% of children with epilepsy show continuous problems with learning, whereas only 4% of healthy children do so [47]. Parents of children with epilepsy report that one of the leading problems is remembering of information learned at school [48]. Braakman et al. indicated that up to 76% of children with FLE have problems with school achievement and 30% have special educational needs [49,20]. In recent literature, some data indicate that epilepsy can affect not only cognitive functioning but also IQ level in general. Moorhouse et al. showed that intelligence impairment can be higher among patients with epilepsy, especially in General Epilepsy [50].

There is a great need for research concerning the complete profile of cognitive function of paediatric patients suffering from epilepsy. There is an opportunity to use neuropsychological assessment in the follow-up care of patients with diagnosed epilepsy. Long-term studies with the repetitive measurements, and comparison to a homogenous control group would provide a more detailed picture in this group of patients. It would make it possible to create a broad support plan which would take into account the training of cognitive functions. These patients should be provided with multidisciplinary care, including not only a neurology specialist but also a neuropsychologist and even a psychiatrist or supporting teacher.

The biggest limitation of our work is lack of full assessment of executive functions in examined groups. Our focus was mainly on verbal and visuospatial memory, attention, the learning processes and working memory which is part of executive functions. As Operto et al. suggested, difficulties in executive functions among children and adolescents with epilepsy can be related to deficits in facial emotion recognition. This connection should be investigated in future studies [51]. The limitation of this study could also have been possible role of medications and their effect on cognitive functioning of examined patients. Monotherapy in antiepileptic treatment reduces this risk but doesn't eliminate it. It seems to be important that patients from both examined groups were asked about side effects concerning cognitive and psychomotor functioning. All patients negated this kind of side effects. Diagnosis of epilepsy based on

the routine EEG and interictal epileptiform discharges can be also treated a limitation. To diminish this limitation in presented study, diagnosis of TLE and FLE were based on semiology of seizures and EEG. All inconclusive cases were excluded from the study.

5. Conclusions

Consistently with the literature, our study demonstrated significantly lower level of cognitive function in children and adolescents with FLE and TLE compared to healthy children specific cognitive difficulties described in the literature concern memory, attention and executive functions. In our work the children suffering from epilepsy showed deficits in memory, attention and learning curve compared with healthy children. The obtained results were worse in the second assessment of patients with the FLE than children with TLE. This tendency was visible in all assessed functions except for verbal memory. Patients suffering from focal epilepsy demonstrated deficits in many aspects of cognitive functioning already at the time of diagnosis. These findings beg the question whether these changes do not precede the onset of first seizure.

Full neuropsychological examination is essential at the time of diagnosis, as well as dynamic re-assessment during the illness. This could provide an appropriate, individualized therapeutic plan which would include multi-disciplinary cooperation in order to improve functioning and the quality of life in this group of patients.

Author contribution statement

Martyna Domańska: Marta Zawadzka: Conceived and designed the experiments; Performed the experiments; Analysed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Seweryna Konieczna: Maria Mazurkiewicz: Contributed reagents, materials, analysis tools or data; Wrote the paper.

Data availability statement

Data will be made available on request.

Additional information

No additional information is available for this paper.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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