Examination of Retinal and Choroidal Structural Changes in Children With Attention Deficit/Hyperactivity Disorder

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Research Article

Keywords: Attention Deficit Hyperactivity Disorder, retinal nerve fiber layer thickness, choroid, optical coherence tomography

Posted Date: April 19th, 2021

DOI: <https://doi.org/10.21203/rs.3.rs-341702/v1>

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Abstract

Objective

Examination of retinal nerve, ganglion cell layer thickness and choroidal thickness in patients with Attention Deficit Hyperactivity Disorder by optical coherence tomography (OCT).

Method

: 30 individuals with Attention Deficit Hyperactivity Disorder and 30 healthy individuals compatible in terms of age and gender who applied to the Ophthalmology outpatient clinic for control were included in the study. The right and left eye data of the participants were used in statistical analysis. In addition to full ophthalmological examination (best corrected visual acuity, biomicroscopy, fundus examination), retinal nerve fiber layer (RNFL), ganglion cell layer (GCL) and macular choroidal thickness (MCT) were measured by OCT. RNFL, GCL and MCT measurements were compared between the groups.

Conclusion

There was no significant difference between the RNFL and GCL thickness values of the individuals in both groups ($p > 0.05$). When compared in terms of choroidal thickness, left eye subfoveal choroidal thickness ($p = 0.036$, $p < 0.05$) and 2 mm temporal choroidal thickness were significantly higher in the ADHD group than in the control group ($p = 0.034$, $p < 0.05$).

Discussion

The aim of this study was to determine the clinical features of the eyes of children with ADHD. Cross-sectional studies with larger participation are needed to determine RNFL, GCL and choroidal changes.

Introduction

Attention deficit hyperactivity disorder (ADHD) is the most common neurobehavioral disorder in childhood, and its prevalence has been reported to be between 2% and 18% in children aged 6–17 years in developed countries (1–3). The incidence of ADHD in a multicenter study conducted in Turkey has been reported to be 12.4% (4). ADHD is associated with difficulties experienced in social, academic, cognitive and emotional performance areas (5). Basic symptoms are attention deficit, hyperactivity and impulsivity (6). The combined type, which includes all three symptom groups, is the most common ADHD type (7). In brain imaging studies, it has been reported that there are neuroanatomical and functional differences in ADHD patients compared to the normal population. Although the time of its formation, the specific region, and the characteristics of these morphological changes have not yet been determined, ADHD is today referred to as a neurodevelopmental disorder (8). The optic nerve and retina, which differ

from the diencephalon in the embryonic development process, have been accepted as a part of the central nervous system (9). Therefore, the retinal layer has an important place in studies on neurodevelopmental disorders.

Studies investigating visual functions and ocular features of children with ADHD are related to visual activity, strabismus, refractive errors, optic disc and neural rim structure, and cognitive visual problems (10). Retinal involvement in the cognitive functions of patients with ADHD are retinal ganglion cell loss in histopathological studies and reduction in retinal nerve fiber layer thickness detected in in vivo studies (11).

Undoubtedly, the diagnosis and treatment of ocular pathologies in children with ADHD will contribute to the quality of life. Therefore, we aimed to compare retinal and choroidal changes in children with ADHD with the control group. In addition, we determined other possible pathologies, especially refractive error, with a detailed eye examination and aimed early diagnosis and treatment.

Method

Participants

The study consisted of two groups of participants from Ophthalmology and Child&Adolescent Mental Health and Diseases Department, Faculty of Medicine Hospital, Cumhuriyet University in Sivas, Turkey. The ADHD group was composed of patients diagnosed with ADHD. The control group was selected from the children, compatible in terms of age and gender, who applied to the ophthalmology department for eye examination, had no history of ocular disease other than refractive errors, and had no psychiatric disorder. Patients with refractive error for each eye $> \pm 3.0$ dioptre, axial length of the eyeball > 26 mm, cup / disc ratio > 0.3 , cup / disc ratio asymmetry ratio between the two eyes > 0.2 , previous eye surgery, glaucoma, uveitis, amblyopia in any eye, children with the treatment for retinopathy of prematurity were excluded from the study.

Ethical committee approval for the study was obtained from Cumhuriyet University Medical Faculty Hospital.

In addition, written informed consent in accordance with the World Medical Association Helsinki Declaration was obtained from at least 1 parent of all children included in the study.

Procedure

In the study, detailed eye examinations and OCT (OCT RS-3000 Advance, NIDEK CO. LTD., JAPAN) imaging of participants were performed.

Retinal nerve fiber layer (RNFL) thickness, ganglion cell layer (GCL) thickness and macular choroidal thickness (MCT) were measured on OCT. Average RNFL thickness and RNFL thickness in 4 quadrants

(nasal, temporal, superior, inferior) were recorded. RNFL thickness was measured in an area of $6 \times 6 \text{ mm}^2$ so that the center was optic disc, and the GCL thickness was measured in an area of $12 \times 8 \text{ mm}^2$ so that the center was fovea. MCT was measured from 5 different points in the area between the outer hyperreflective border of the retinal pigment epithelium and the inner scleral surface, from 5 different points, 1 and 2 mm nasal and temporal of the subfoveal and fovea.

Statistical Analysis

The data obtained from the study were loaded into the SPSS 22.0 program. When the parametric test assumptions were fulfilled in the evaluation of the data (KolmogorovSmirnov), Student's t test was used to compare the measurements obtained from two independent groups in terms of an obtained variable and the Chi-square test was used to evaluate the data obtained by counting, and the level of error was taken as 0.05.

Results

Of the individuals in the patient group, 9 (30%) were female, 21 (70%) were male, 10 (33.3%) of the individuals in the control group were female, and 20 (66.7%) were male. The difference between groups in terms of gender was not statistically significant. ($p > 0.05$)

The mean age was 9.90 ± 2.15 years in ADHD and 9.10 ± 2.80 years in the control group. When the individuals in both groups were compared in terms of age, the difference between the groups was not statistically significant. ($p > 0.05$)

OCT measurements of 60 eyes of 30 children with ADHD and 60 eyes of 30 individuals in the control group were compared. When the individuals in both groups were compared in terms of RNFL four quadrants and in terms of right-left eye, the difference was not statistically significant. ($p > 0.05$) (Table 1)

Table 1
RNFL Thickness Values of Individuals

RNFL Thickness (Mean ± SD) (µm)	ADHD Group (n = 60)	Control Group (n = 60)	p value
Right Upper Quadrant	130.4 ± 16.1	127.7 ± 15.6	0.519
Left Upper Quadrant	134.7 ± 15.4	131.7 ± 11.6	0.405
Right Nasal Quadrant	76.6 ± 11.4	76.5 ± 11.4	0.265
Left Nasal Quadrant	73.7 ± 9.5	72.7 ± 8.2	0.955
Right Lower Quadrant	137.8 ± 17.1	137.9 ± 16.3	0.221
Left Lower Quadrant	143.0 ± 19.0	140.6 ± 14.7	0.988
Right Temporal Quadrant	70.5 ± 9.8	71.7 ± 10.9	0.587
Left Temporal Quadrant	67.6 ± 9.4	70.5 ± 10.4	0.658

When the GCL thickness of individuals in both groups were compared in terms of upper, lower, mean and right-left eye, the difference was not statistically significant ($p > 0.05$). (Table 2)

Table 2
GCL Thickness Values of Individuals

GCL thickness (Mean ± SD) (µm)	ADHD Group (n = 60)	Control Group (n = 60)	p değeri
Right Upper Quadrant	99.8 ± 9.8	127.9 ± 16.7	0.363
Left Upper Quadrant	99.0 ± 10.3	96.8 ± 7.9	0.345
Right Lower Quadrant	100.5 ± 10.1	97.9 ± 9.8	0.324
Left Lower Quadrant	100.4 ± 9.3	99.2 ± 8.5	0.616
Right Mean	100.2 ± 9.6	97.7 ± 8.2	0.302
Left Mean	99.8 ± 9.5	98.0 ± 7.9	0.426

When the individuals in both groups were compared in terms of choroidal thickness, a significant difference was found in terms of left central choroidal thickness and left temporal 2 mm choroidal thickness ($p < 0.05$), while the difference between the groups in terms of other measurements was not statistically significant ($p > 0.05$).

Table 3
Choroid Thickness Values Of Individuals

MCT (Mean ± SD) (µm)	ADHD Group (n = 60)	Control Group (n = 60)	p value
Right subfoveal choroidal thickness (µm)	390.6 ± 66.8	379.6 ± 61.3	0.510
Left subfoveal choroidal thickness (µm)	391.1 ± 75.6	353.9 ± 57.1	0.036*
Right nasal 1 mm choroidal thickness (µm)	327.5 ± 65.6	322.2 ± 60.8	0.748
Left nasal 1 mm choroidal thickness (µm)	325.5 ± 74.1	292.7 ± 59.8	0.064
Right nasal 2 mm choroidal thickness (µm)	293.3 ± 66.8	290.5 ± 59.0	0.861
Left nasal 2 mm choroidal thickness (µm)	291.5 ± 71.8	264.6 ± 54.7	0.107
Right temporal 1 mm choroidal thickness (µm)	340.9 ± 54.5	330.0 ± 57.9	0.456
Left temporal 1 mm choroidal thickness (µm)	354.7 ± 72.2	326.3 ± 47.1	0.176
Right temporal 2 mm choroidal thickness (µm)	321.0 ± 51.1	311.0 ± 58.2	0.483
Left temporal 2 mm choroidal thickness (µm)	331.7 ± 73.8	297.3 ± 45.3	0.034*
Mean ± SD: Mean ± Standard deviation, µm = micrometer, *p < 0.05 significant			

Discussion

The aim of this study was to determine the clinical features of the eyes of children with ADHD. Cross-sectional studies with larger participation are needed to determine RNFL, GCL and choroidal changes.

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