

Association between ocular trauma and attention-deficit/hyperactivity disorder in adult patients

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Purpose: To investigate the potential relationship between ocular trauma and attention-deficit/hyperactivity disorder (ADHD)-related clinical outcomes in adults. **Methods:** This prospective case-control study included 108 ocular trauma patients and 90 age-sex-matched healthy control. The ocular trauma group was separated into the subgroups home accident, outdoor activity, and work related in terms of the reasons for ocular trauma, and as ocular surface problems, blunt trauma-related, and open globe injury in terms of the clinical findings. The ADHD-related clinical outcomes were evaluated using the Wender-Utah Rating Scale (WURS). The outcomes were compared between ocular trauma and control groups, and ocular trauma subgroups. **Results:** The demographic characteristics of ocular trauma groups and controls were similar ($P > 0.05$, for all). In comparison to the control group, the ocular trauma group had higher total WURS score and WURS subscale scores, but not significantly ($P > 0.05$, for all). According to comparisons of the subgroups separated by the reasons, there was significant difference in the mean behavioral problems/impulsivity scores in favor of outdoor activities ($P = 0.015$). On the other hand, the mean scores for WURS subscales of the subgroups separated by the clinical findings were similar ($P > 0.05$, for all). **Conclusion:** WURS scores in ocular trauma patients are similar to control; however, the score in behavioral problems/impulsivity subscales is higher for ocular trauma caused by outdoor activities.

Key words: ADHD, attention-deficit/hyperactivity disorder, ocular trauma, trauma, Wender-Utah Rating Scale

Ocular trauma is one of the most important causes of permanent vision loss and still has an important place among the reasons for decreasing the quality of life.^[1] Even the less serious traumas cause pain and discomfort, resulting in loss of labor and maintenance and treatment costs. Despite advances in diagnosis and treatment methods, ocular trauma remains socially and economically important, as affected individuals are mostly of working age.^[1] To reveal the population at risk and the causes of ocular traumas may be the first and the most important step for preventive measures.

Attention-deficit/hyperactivity disorder (ADHD) is a developmental neuropsychiatric disorder beginning in early childhood. It is characterized by inattention, hyperactivity, and impulsivity. Longitudinal studies show that childhood ADHD symptoms persist in adolescence and adulthood.^[2,3] It also causes serious impairment of the daily life functioning in the affected adults.^[4]

The risk of accident and trauma increases in people with ADHD compared to the normal population.^[5] It is suggested

that ADHD behavioral characteristics are responsible for this increased risk. These features include motor coordination problems, risk-taking aggression behaviors, hyperactivity, impulsivity, and attention problems of ADHD.^[6,7] Because of these features of the disorder, hospital admissions increase and many departments are consulted for accidents and trauma.^[8]

The primary aim of this study is to investigate whether the ADHD-related clinical outcomes are more common in adults presenting with ocular trauma than the healthy control. Secondly, it was also aimed to investigate the relationship between ADHD-related clinical outcomes and ocular trauma subgroups separated by the reasons for trauma and clinical findings.

Methods

This prospective case-control study was conducted at a single tertiary referral hospital. Approval was granted by the Local Research Ethics Committee. All procedures were performed in accordance with the ethical standards of the Helsinki Declaration for human subjects, and written informed consent was obtained from each patient after a detailed explanation.

The study group was conducted with Caucasian ocular trauma patients and had the following inclusion criteria:

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1) age ≥ 8 and ≤ 65 years old; 2) accidental trauma incident effecting eye globe; and 3) primary school graduation or higher education level. The exclusion criteria were as follows: 1) mentally retardation, epilepsy, or cognitive disability; 2) history of any psychiatric or mood affective drug using; 3) history of alcohol or any kind of drug addiction; and 4) history of monocular or binocular visual loss. The control group was conducted with age- and sex-matched healthy Caucasian subjects presented to the ophthalmology clinic for routine ocular examination or refractive error, who met the same inclusion and exclusion criteria.

All ocular trauma patients underwent a detailed ophthalmological evaluation including the best-corrected visual acuity with Snellen chart (then converted into logarithm minimal angle resolution), intraocular pressure with pneumotonometer (if open globe injury was excluded), and anterior and posterior segment with a slit-lamp biomicroscope (ocular ultrasonography for patients with complete ocular media opacification when open globe injury was excluded). The patients were also evaluated for other systemic trauma-related findings and imaging techniques and medical consultations were performed for those needed. The ocular trauma group was separated into three subgroups according to reasons for ocular trauma as home accident, outdoor activities (e.g., sport, camping, falling, gaming, fighting, or car accident), and work related. Similarly, the study group was also separated into three subgroups according to clinical findings, including ocular surface problems (e.g., corneal abrasion or chemical injury), blunt trauma related (e.g., hyphema, cataract, or retinal edema), and open globe injury (e.g., penetration, perforation, or intraocular foreign body). Sociodemographic data containing age, sex, previous trauma history, duration of education, and family income were questioned. Family income was categorized as low income (lower than monthly 800 USD for four persons) and middle-to-high income (equally or higher than monthly 800 USD for four persons). Wender-Utah Rating Scale (WURS) was performed for patients after an explanation for scoring details. Sociodemographic data investigation and WURS scoring were performed after the primary care for ocular trauma of the patients. The same evaluations were also performed for the control groups at the same day of their presentations.

Twenty-five-item short form of WURS that identifies adults with ADHD who distinguish them from non-ADHD controls was performed for the subjects. The validity and reliability study of the Turkish version was done by Öncü *et al.*^[9] The internal consistency analysis showed that the scale was high and the subscales had reliable Cronbach's alpha values at the middle level. Internal consistency coefficients of subscales are: irritability 0.88, depression 0.78, school problems 0.57, behavioral problems/impulsivity 0.79, attentional deficits 0.80, and overall scale 0.93. The test-retest reliability value is 0.81. Cutting score is 36. The factor 8 is calculated by reversing for the negative factor load.^[10] In accordance with the Likert scale, each item is scored from zero point to four points (zero point is equal to none and four points is equal to severe) and 36 points was determined as a cut-off value.^[11]

Statistical analysis

The statistical analysis was performed using the Statistical Package for the Social Sciences (SPSS) 22.0 (IBM Corp., Armonk,

NY, USA). The results were presented as the mean \pm standard deviation (minimum–maximum) value. Chi-square test was used in the analysis of categorical variables. The normality of the numeric data was evaluated using the Kolmogorov–Smirnov test, and it was found that the numeric data did not fit the normal distribution. In order to compare multiple groups, Kruskal–Wallis H test was applied. Mann–Whitney *U* test was performed for comparing two groups. Correlation was tested with Spearman's correlation analysis. A *P* value of less than 0.05 was considered statistically significant.

Results

The mean age of the subjects was 35.95 ± 12.48 years (18–65) in the ocular trauma group ($n = 108$) and 34.20 ± 12.84 years (18–65) in the control group ($n = 108$). The male-to-female ratios were 90/18 in the ocular trauma group and 73/17 in the control group. There was no significant difference between groups when comparing the baseline sociodemographic characteristics of the groups ($P > 0.05$, for all), and the details are given in Table 1.

The mean total WURS score was 18.85 ± 16.24 (0–79) in the ocular trauma group and 16.14 ± 10.91 (0–49) in the control group ($P = 0.683$). Fourteen patients had above cut-off WURS score in the ocular trauma group and six patients had in the control group ($P = 0.143$). In analysis of WURS subscales, the mean scores for other WURS subscales were similar between control and ocular trauma groups ($P > 0.05$, for all). The details of the WURS scores of ocular trauma and control groups are shown in Table 2.

In comparison for ocular trauma subgroups and controls separated by the reasons for ocular trauma, including home accident ($n = 32$), outdoor activities ($n = 38$), and work related ($n = 38$), the mean total WURS scores and the numbers for patients above cut-off value were similar between the groups ($P > 0.05$, for both). There was also no significant difference in the mean scores for WURS subscales, including irritability, depression, school problems, and attentional deficits between the groups ($P > 0.05$, for all). In contrast, there was a significant difference in the mean behavioral problems/impulsivity scores ($P = 0.043$). In the posthoc analysis for these subscales, the mean WURS scores were significantly higher in the subgroup of outdoor activities when comparing with the home accident subgroup ($P = 0.015$). The details of the WURS scores of ocular trauma subgroups separated by the reasons are presented in Table 3. The mean WURS scores of ocular trauma subgroups and controls are demonstrated in Fig. 1.

In comparison for ocular trauma subgroups and controls according to the clinical findings, including ocular surface problems ($n = 47$), blunt trauma-related ($n = 20$), and open globe injury ($n = 41$), the mean total WURS scores and the numbers for patients above cut-off value were similar between the groups ($P > 0.05$, for both). In addition, there was no significant difference in the mean scores for WURS subscales between the groups ($P > 0.05$, for all). The details of the WURS scores of ocular trauma subgroups separated by the clinical findings are demonstrated in Table 4.

No significant correlation was observed between the visual acuity and total WURS score in ocular trauma cases ($\rho = -0.087$, $P = 0.372$).

Discussion

Most of the ocular trauma patients in this study are composed of young and male patients in accordance with the literature.^[1,12,13] Some sociodemographic characteristics, including lower education level and lower income, have been reported as associated with higher risk for ocular trauma.^[1,12,13] Higher education level and higher income increase the awareness and accessibility in using of personal protective equipment and techniques and prevent further traumas. According to the results of this study, there was no significant difference in ocular trauma patients in terms of duration of education, family income, and previous trauma history. Determining as exclusion criteria of primary school graduation may affect the outcomes because some illiterate ocular trauma patients could not be included into the study.

Many studies highlight the relationship between ADHD and trauma incidents in pediatric population.^[14-18] On the other hand, in the literature, there are relatively limited reports on the relationship between ADHD and trauma in adults. Kaya *et al.*^[19] reported that patients with adult ADHD are susceptible to musculoskeletal traumas, especially high-energy traumas such as motor vehicle accidents. Likewise, in a study conducted by Kömürçü *et al.*,^[20] the relationship between ADHD and extremity fractures was examined and they

found that extremity fractures are associated with ADHD symptoms in adults. Chang *et al.*^[21] showed that ADHD is associated with an increased risk of serious car accidents, and this risk is likely to be diminished by ADHD medications. In the literature review, only two studies carried out on the relationship between penetrating eye traumas and ADHD in children can be found.^[15,22] The significant association found in their studies gives rise to consider the negative impact of ADHD on the ocular traumas in pediatric patients.^[15,22] This study intends to investigate the role of ADHD-related clinical findings in ocular traumas in adult population, which to the best of our knowledge has not yet been studied. Patients with ocular trauma had a higher total WURS score and WURS subscale scores than controls in our study, but this was not at the level of significance. These results may be best explained by the regression of hyperactivity and impulsivity symptoms, the decrease in the prevalence of ADHD in adulthood, and the fact that ocular trauma is a relatively localized trauma.^[23,24] To reveal whether there was presence of a potential relationship between ADHD and ocular trauma, the analysis was extended according to ocular trauma subgroups separated by the reasons for ocular trauma and the associated clinical findings.

In this study, the reasons for ocular trauma were categorized into three main subgroups as home accident,

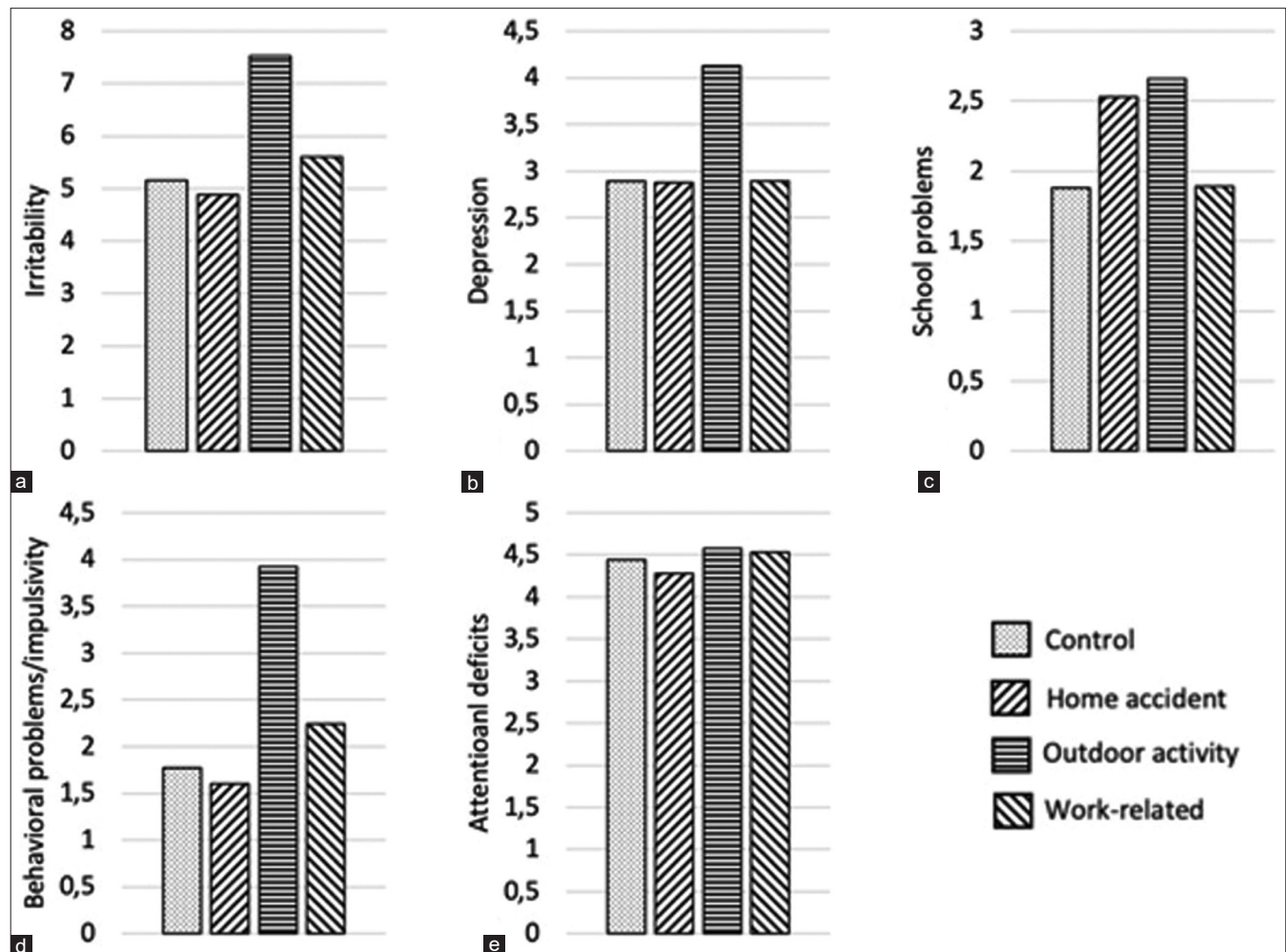


Figure 1: The subscale scores of Wender-Utah Rating Scale in controls and ocular trauma subgroups separated according to the reasons. (a) Irritability, (b) depression, (c) school problems, (d) behavioral problems/impulsivity, and (e) attentional deficits

Table 1: Baseline sociodemographic characteristics of ocular trauma and control groups

	Ocular trauma (n=108)	Control (n=90)	P
Age (years)	35.95±12.48 (18-65)	34.20±12.84 (18-65)	0.332
Sex (male/female)	90/18	73/17	0.683
Previous trauma history (yes/no)	24/84	13/77	0.162
Duration of education (years)	9.24±3.90 (5-21)	10.14±3.62 (5-18)	0.064
Family income (low/middle-to-high)	49/59	34/56	0.281

Table 2: The details of the WURS scores of ocular trauma and control groups

	Ocular trauma (n=108)	Control (n=90)	P
WURS scores			
Total	18.85±16.24 (0-79)	16.14±10.91 (0-49)	0.683
Cut-off (above/under)	14/94	6/84	0.143
WURS subscales			
Irritability	6.06±6.36 (0-24)	5.16±4.71 (0-19)	0.841
Depression	3.32±3.41 (0-16)	2.89±2.75 (0-11)	0.572
School problems	2.35±2.46 (0-10)	1.88±1.90 (0-7)	0.347
Behavioral problems/impulsivity	2.64±3.64 (0-19)	1.77±2.31 (0-12)	0.229
Attentional deficits	4.47±3.42 (0-18)	4.44±3.00 (0-13)	0.625

WURS: Wender-Utah rating scale.

Table 3: The WURS scores of ocular trauma subgroups separated by the reasons

	Ocular trauma subgroups separated by the reasons			P
	Home accident (n=32)	Outdoor activities (n=38)	Work-related (n=38)	
WURS scores				
Total	16.16±14.00 (0-58)	22.82±19.12 (2-79)	17.16±14.40 (2-61)	0.202
Cut-off (above/under)	4/28	6/32	4/34	0.789
WURS subscales				
Irritability	4.88±5.81 (0-24)	7.53±6.98 (0-24)	5.61±6.04 (0-20)	0.201
Depression	2.88±3.53 (0-14)	4.13±3.70 (0-16)	2.89±2.93 (0-13)	0.115
School problems	2.53±2.23 (0-8)	2.66±2.58 (0-10)	1.89±2.51 (0-10)	0.171
Behavioral problems/impulsivity	1.60±2.39 (0-8)	3.92±4.87 (0-19)	2.24±2.66 (0-10)	0.043*
Attentional deficits	4.28±2.94 (0-14)	4.58±3.91 (0-18)	4.53±3.35 (0-11)	0.986

WURS: Wender-Utah rating scale. *P=0.015 for home accident vs. outdoor activities; P=0.160 for home accident vs. work-related; P=0.196 for outdoor activities vs. work-related.

Table 4: The WURS scores of ocular trauma subgroups separated by the clinical findings

	Ocular trauma subgroups separated by the clinical findings			P
	Ocular surface problems (n=47)	Blunt trauma-related (n=20)	Open globe injury (n=41)	
WURS scores				
Total	19.68±15.29 (4-78)	17.50±17.77 (0-68)	18.56±16.86 (2-79)	0.523
Cut-off (above/under)	6/41	3/17	5/36	0.953
WURS subscales				
Irritability	6.45±6.37 (0-24)	4.90±6.71 (0-20)	6.20±6.28 (0-24)	0.301
Depression	3.43±3.36 (0-16)	3.75±4.13 (0-14)	3.00±3.15 (0-13)	0.725
School problems	2.60±2.50 (0-10)	2.25±2.07 (0-7)	2.12±2.61 (0-10)	0.407
Behavioral problems/impulsivity	2.40±2.86 (0-12)	2.75±4.13 (0-16)	2.85±4.23 (0-19)	0.949
Attentional deficits	4.80±3.50 (0-17)	3.85±2.81 (0-11)	4.39±3.62 (0-18)	0.515

WURS: Wender-Utah rating scale.

outdoor activities, and work related. Probably, the most important outcome of this study is to find out a significant difference in WURS scores for behavioral problems/impulsivity WURS subscales and there is important dissociation in some ocular trauma reasons. According to this result, ocular traumas related to some physical activities, such as many kinds of sports, camping, fighting, driving a motor vehicle, or going into traffic which are categorized as outdoor activities (actually it indicates the reasons other than home- or work-related traumas), are more associated with ADHD-related clinical findings especially behavioral problems/impulsivity than are ocular traumas after home accidents. In accordance with this result, Fischer *et al.*^[25] reported significantly worse outcomes in motor vehicle driving behavior, performance, and history of adverse driving for hyperactive children followed into young adulthood. In this regard, these kinds of physical activities can be riskier for those people in the risk group, and more protective and preservative approaches may be necessary. On the other hand, psychiatric consultation may be needed for those who have suffered repeated traumas related to outdoor activities.

Using Conner Parent Rating Scale, Bayar *et al.*^[15] reported that ADHD symptoms (inattentiveness, hyperactivity, oppositional defiant disorder, and conduct disorder) were significantly higher in all subscales than the control group in 45 pediatric patients with open globe injury. Similarly, Kafali *et al.*^[22] determined significantly higher incidence of ADHD, mainly inattentiveness, hyperactivity subscales in 39 children with open globe injury. In addition to reasons for ocular trauma, the results of the patients were reviewed according to ocular trauma-related clinical finding or classification, including ocular surface problems, blunt trauma-related, and open globe injury. It is very hard to consider the presence of any causality relationship because clinical findings can be in a large spectrum (such as ocular surface foreign body as a mild ocular trauma or intraocular foreign body as a severe ocular trauma) after two different incidents with the similar mechanism. In this study, any significant outcome could not be found between ocular trauma subgroups separated by clinical findings. In the presence of some methodological differences, including investigation of adult population who had ocular traumas with different mechanisms, larger sample size and using another testing technique to evaluate ADHD can clarify the results of this study which conflict with the results of previous studies.

Being a single center study and including a limited number of patients in the subgroups are limitations of the research. All surveys were screening tests and the subjects were not clinically evaluated by a psychiatrist and a clinical psychologist. In addition, the lack of tests that could identify comorbid diseases, including antisocial personality disorder, anxiety disorder, dysthymic disorder, or major depression, caused this study to be limited. Patients with ADHD may have filled the questionnaire more carelessly. Therefore, it may have caused the test results to be lower than the real version in this population. Further studies with the clinical supervision of a psychiatrist may provide more comprehensive data about psychiatric disorders. Larger studies with long-term follow-up should be performed in the future to assess the clinical impact of ADHD on ocular trauma.

Conclusion

In conclusion, WURS scores in ocular trauma patients are similar to control; however, the scores in behavioral problems/impulsivity subscale as a clinical finding related to ADHD are higher for ocular trauma caused by outdoor activities than home accidents.

Ethics approval

The study was approved by the Institutional Review Board/Ethics Committee of Numune Training and Research Hospital, Ankara, Turkey (protocol no: E-16-980). All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

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Conflicts of interest

There are no conflicts of interest.

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