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| **Appendix 1. Literature summary on visual function in ADHD** | **Objective** | **Participants** | **Method** | **Results** | **Conclusions** |
| Granet et al. (2005, Strabismus) | The purpose of the study was to determine any correlation between convergence insufficiency (CI) and ADHD, as it is not clear if these pathologies co-exist, are inter-causal or are misdiagnosed for each other.  | 266 patients with a diagnosis of CI from an academic pediatric ophthalmology practice participated.1705 patients with a diagnosis of ADHD were identified from a computerized review of the University of California, San Diego (UCSD) Medical Records’ database. | A retrospective review of the 266 patients with a diagnosis of CI was obtained from the UCSD Ratner Children’s Eye Center’s electronic database was performed. Patients with history of ADHD were identified.A computerized review was also performed looking at the converse incidence of CI in patients carrying the diagnosis of ADHD. | From the 266 charts of patients with CI, 26 patients (9.8%) had a history of ADHD. Of the patients with ADHD and CI, 20 (76.9%) were on medication for ADHD at the time of diagnosis for CI.The review of computer records showed a 15.9% incidence (28 patients out of 1705) of CI in the ADHD population. | The authors report a three-fold greater incidence of ADHD among patients with CI when compared with incidence of ADHD in the general US population (1.8-3.3%). They also note a seeming three-fold greater incidence of CI in the ADHD population. |
| Borsting, Rouse, & Chu (2005, Optometry) | The purpose of the study was to evaluate the frequency of ADHD behaviors in school-aged children with symptomatic accommodative dysfunction or CI. | 24 children aged 8-15 years (mean age 10.9 years), 9 boys and 15 girls, with symptomatic accommodative dysfunction and/or CI participated. | One parent of each child completed the Connors Parent Rating Scale-Revised Short Form (CPRS-R:S). | On the CPRS-R:S, cognitive problem/inattention, hyperactivity, and ADHD index were significantly different from normative values. | The results from this preliminary study suggestthat school-aged children with symptomatic accommodativedysfunction or CI have a higher frequency of ADHD-like behaviors as measured by the CPRS-R:S. |
| Rouse et al. (2009, Optometry and Vision Science) | The purpose of the study was to determine if children with symptomatic CI without the presence of parent-reported ADHD have higher scores on the academic behavior survey. | 212 children (mean age 11.8 years) with symptomatic CI participated.The control group consisted of 49 children with normal binocular vision (NBV; mean age 12.5 years). | Parents/guardians of children with symptomatic CI or NBV completed the academic behavior survey (ABS) and reported whether the child had ADHD. | 16% of the CI group and 6% of the NBV group were classified as ADHD by parental report. Total ABS score for symptomatic CI with parent report of ADHD group was significantly higher than the symptomatic CI with parent report of no ADHD group and the NBV group. | Children with CI with parent report of no ADHD scored significantly higher on the ABS when compared to children with NBV. |
| Grölund et al. (2007, Eye) | The purpose of the study was to investigate visual function and ocular features in children with ADHD and establish whether treatment with stimulants is reflected in functioning of the visual system. | 42 children and adolescents with ADHD aged 6.3-17.6 years (mean age 12 years), 37 boys and 5 girls, who were being treated with stimulants participated. Children had been on medications for a mean period of 19.5 months.The control group consisted of 50 school children (mean age of 11.9 years), 44 boys and 6 girls. | Ophthalmologic tests were first performed without medication:- Visual acuity (VA)- Strabismus and ocular motility (heterotropia)- Stereo acuity - Near point of convergence (NPC)- New point of accommodationAfterwards the children were given their regular drugs. After at least 60 min, all tests were performed in the same order with medication. In addition, the following tests were performed:- Refraction under cyclopegia- Assessment of ocular dimensions - Examination of anterior segment, media, and ocular fundus - Photography of the ocular fundus for quantitative digital image analysis- History taking of visual perception | 76% of children with ADHD had ophthalmologic findings including subnormal VA, strabismus, reduced stereo vision, absent or subnormal NPC, refractive errors, small optic discs and/or signs of cognitive visual problems.The children had an increased proportion of heterophoria and poorer performance on visual acuity and convergence tests without, but not with, stimulants when compared with controls. | Children with ADHD had a higher frequency of ocular and visual abnormalities. Treatment with stimulants caused no significant difference in visual function. They presented subtle morphological changes of the optic nerve and retinal vasculature, indicating an early disturbance of the development of neural and vascular tissues in the CNS. |
| Martin et al. (2008, ActaOphthalmologica) | The purpose of this study was to evaluate visual function in children with ADHD, to correlate these data with the morphology of the optic nerve, and to find out if and how psychostimulant medication affects visual functions. | 18 children aged 6-17 years (mean age 11.9 years), 16 boys and 2 girls, diagnosed with ADHD and treated with stimulants participated. Children had been on medication for a mean period of 14.7 months. ADHD diagnoses were determined according to DSM-IV criteria by one physician in all patients.The control group consisted of 24 children aged 7-18 years (mean age 11.7 years), 15 boys and 9 girls. | Both groups underwent an ophthalmological examination including best corrected distance visual acuity (BCVA), visual field examination, and fundus photography.The ADHD children did not take medication on the morning of the initial examination. Two hours later, the children were given their regular drug doses and the examinations were repeated. The control group was examined twice, at the same time intervals as the ADHD group. | Visual acuity increased significantly in the ADHD group after treatment. The difference between the two VF examinations was significantly larger in the ADHD compared with the control group.Significantly more ADHD subjects had subnormal VF results without stimulants, compared with controls, but with stimulants the difference was no longer significant. | Children with ADHD showed better VA and VF results with than without psychostimulant medication. |
| Chung et al. (2012, Yonsei Med J) | The purpose of the study was to investigate the symptoms of ADHD as reported by parents in children with intermittent exotropia [X(T)] and to determine whether strabismus surgery for X(T) affects ADHD symptoms. | 51 children undergoing muscle surgery for X(T) aged 3-9 years (mean age 5.96 years), 22 boys and 29 girls, participated. All patients had either divergence excess or basic type X(T). | One parent of each child completed the ADHD rating scale IV (ADHD RS-IV) assessment, based on the DSM-IV home version, consecutively before and one year after surgery (symmetric lateral rectus recession on both eyes). | 8 (15.7%) of the 51 patients demonstrated the ADHD trait. ADHD RS-IV scores following strabismus surgery significantly decreased in patients with the ADHD trait, while they did not differ in patients without the ADHD trait. 7 of the 8 patients with the ADHD trait showed improvement in their ADHD RS-IV scores after surgery. | The ADHD trait was relatively common in children with X(T), and the parent-reported symptoms of the children with the ADHD trait improved after strabismus surgery. |