CORRELATION BETWEEN ADHD AND ACCOMMODATIVE INSUFFICIENCY

by

Scott Kass

Has been approved

May, 2014

APPROVED:

_____, Faculty Advisor

ACCEPTED:

_____

Faculty Course Supervisor

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Scott Kass

This paper is submitted in partial fulfillment of the
requirements for the degree of

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Doctor of Optometry Senior Paper

Library Approval and Release

# CORRELATION BETWEEN ADHD AND ACCOMMODATIVE INSUFFICIENCY

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Doctoral Candidate

3/28/2014
Date

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ABSTRACT

*Background*: Attention-deficit/hyperactivity disorder (ADHD) is currently one of the most commonly diagnosed neurobehavioral conditions affecting children.[1] First line treatment for this condition is oral medication, including methylphenidate, amphetamines, atomoxetine, guanfacine, and antidepressants. Many of these medications list “blurry vision” or “headaches” as a side effect. Some ocular abnormalities in children being medically treated for ADHD have been noted in the literature, including convergence insufficiency and accommodative dysfunction. The purpose of this study is to determine if there is a correlation between the use of medication for the treatment of ADHD and the incidence of accommodative insufficiency in children.

*Methods*: A retrospective chart review of children diagnosed with accommodative insufficiency was performed using records of patients seen at the University Eye Center at the Michigan College of Optometry. Inclusion criteria included all children from 7 to 18 years old within the past 5 years with the diagnosis of accommodative paresis or accommodative spasm. These records were then searched for any previous diagnosis of ADD or ADHD and any medications being used to treat the condition. Once the data was compiled, SPSS analysis was performed to determine if there are any statistically significant links between the variables.

*Results*: The charts of 161 children diagnosed with accommodative disorders were reviewed. Of these 161 patients, 30 had a previous diagnosis of ADD or ADHD. SPSS analysis revealed no statistically significant differences in terms of

amplitude of accommodation or difference between actual and expected amplitudes of accommodation between children with ADD or ADHD and children without attention deficits.

*Conclusions*: In total, 18.6% of the children in this study had ADD or ADHD. The results of this study indicate that children using ADD or ADHD medication do not have lower amplitudes of accommodation than children not on ADD/ADHD medication.

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## Background

Attention deficit hyperactivity disorder (ADHD) is currently one of the most commonly diagnosed conditions of children and adolescents. It manifests in early childhood and is characterized by hyperactivity, inattention, and impulsivity.[1] There are three subtypes of ADHD: predominantly hyperactive, predominantly impulsive, and combined type. ADHD is one of the most common childhood neuropsychiatric conditions with an estimated prevalence between 2.2% and 17.8% worldwide.[2] Children and adolescents affected by this condition tend to perform more poorly in school and on standardized tests, and are more likely to exhibit risky behavior, including reckless driving and spontaneous sexual encounters.[1] They also often have lower self-esteem and may suffer from other psychiatric comorbidities.

Even though ADHD is one of the most studied childhood conditions, the exact etiology is not yet fully understood.[3] Some studies suggest that an abnormality in brain structure may be responsible for the behavior seen in ADHD patients. Specifically, the maturation of the prefrontal cortex tends to be slower in patients diagnosed with ADHD.[4] Additionally, the prefrontal cortex, caudate, and cerebellum tend to be smaller in volume and reduced in activity when compared to control patients.[5] It has also been reported that ADHD patients a have reduced density of dopamine receptors, resulting in a reduction in dopaminergic system function.[6] Studies show that patients display symptoms of impaired attention,

impulsivity, and hyperactivity when the α2A receptor's activity is disrupted.[5] In contrast, a number of other studies have reported that a hyperactive dopaminergic system contributes to ADHD behavior.[7] This has led some researchers to conclude that either end of the dopaminergic activity spectrum leads to problems.[5]

ADHD is most commonly treated with medication. Stimulants, including amphetamines and methylphenidate, are widely considered the first line treatment.[8] Amphetamines work by stimulating the release of dopamine and other catecholamines. Additionally, they also serve to block reuptake of catecholamines at synapses. Examples of amphetamines include Adderall and Vyvanse. Methylphenidate, on the other hand, blocks reuptake of catecholamines, but does not cause their release. Examples of methylphenidate formulations include Ritalin and Concerta.[9] Despite their slightly different mechanism of action, amphetamines and methylphenidate are considered to be equally effective in the treatment of ADHD.[10] For patients who either do not respond well to stimulants or cannot tolerate them, non-stimulant options are an alternative. These medications include atomoxetine (Strattera), clonidine (Kapvay), and guanafacine (Intuniv).[1] Like stimulants, atomoxetine increases the availability of catecholamines, while clonidine and guanafacine stimulate α2A receptors directly. Finally, a number of medications are also used off-label for the treatment of ADHD, including bupropion and trycyclic antidepressants.

A number of these medications list visual problems among their adverse effects. However, these warnings tend to be rather vague. For example, Concerta simply lists “eyesight changes or blurred vision” as a potential side effect. Both Ritalin and Adderall include warnings of a possible visual disturbance, with the manufacturers stating only that “difficulties with accommodation and blurring of vision have been reported with stimulant treatment.”

A number of ocular abnormalities in children being treated for ADHD have been noted in the literature, including convergence insufficiency (CI) and accommodative dysfunction. There are two competing theories that attempt to explain this connection. Some researchers suggest that these ocular conditions simply manifest similar behaviors to those seen in patients with ADHD.[11] In fact, it has been proposed that these underlying ocular conditions could potentially lead clinicians to incorrect ADHD diagnoses.[12] Alternately, other researchers believe that immature visuomotor, spatial, and attention processing systems are responsible for both ADHD and ocular problems like CI and accommodative dysfunction.[11]

Accommodative insufficiency is one type of accommodative dysfunction in which the patient has an amplitude of accommodation below age expected normative values, resulting in the inability to focus or maintain focus at near.[13] These patients tend to experience blurriness, irritability, difficulty reading, poor

concentration, and headaches when attempting to focus on near targets. The aim of this study is to examine the relationship between ADHD and accommodative insufficiency. Based on review of the current literature, no direct correlation between the two has been established.

## Methods

A retrospective chart review of children diagnosed with accommodative insufficiency was performed using records of patients seen at the University Eye Center at the Michigan College of Optometry. Inclusion criteria included all children from 7 to 18 years old within the past 5 years with an accommodative diagnosis, including accommodative insufficiency, accommodative spasm, or general accommodative dysfunction. These records were then searched for any previous diagnosis of ADHD and any medications being used to treat the condition. Additional data, including age at the time of diagnosis, gender, amplitude of accommodation, lag of accommodation, and treatment method, was also collected. Throughout this process, records were only included if they contained the signature of a parent or legal guardian allowing the exam information to be used for educational and research purposes.

Once the data was compiled, it was sorted into groups for analysis. For lag of accommodation, a child was considered to have a tight lag if the value was less than +0.25 D. Normal lag of accommodation was considered to be between

+0.25 D and +0.75 D, and a child was determined to have a loose lag if it was greater than +0.75 D. These normative values were determined based on the AOA Clinical Practice Guidelines.[13] For amplitude of accommodation, Hofstetter's formula for minimum expected amplitude was used to determine the minimum normative value for each individual subject based on his or her age. The difference between the minimum expected amplitude and the amplitude reported in the exam record was then taken. Subjects were also grouped by ADD/ADHD with medication compared to no ADD/ADHD and no medication. After grouping all of the data, it was analyzed using SPSS software to determine if any significant links existed between the variables.

**Results**

In total, the charts of 161 children with accommodative insufficiency were reviewed for this study. Thirty of these children, or 18.6%, had a previous diagnosis of ADD or ADHD. Of those, only 3 were unmedicated, 11 had a diagnosis of accommodative insufficiency, and 9 had a diagnosis of accommodative spasm. SPSS analysis revealed no statistically significant difference between patients diagnosed with ADD/ADHD and normal patients in terms of average amplitude of accommodation (Sig = 0.717) or difference between expected and actual amplitude of accommodation (Sig = 0.289). Additionally, no statistically significant difference was found between patients on ADD/ADHD medication and patients not on medication in terms of average amplitude of accommodation (Sig = 0.193) and difference in expected and actual

amplitude of accommodation(Sig = 0.608). An ANOVA analysis was performed looking at three groups: children with ADD/ADHD who were on meds, children who did not have ADD/ADHD and were not meds, and children who had ADD/ADHD who were not being medicated. This analysis revealed no significant difference in terms of average amplitude of accommodation (Sig = 0.465) and difference between expected and actual amplitude of accommodation based on age (Sig = 0.448).

| | Significance | |
|---|---|---|
| | Average Amplitude | Difference Between Actual and Expected Amplitude |
| ADD/ADHD vs. Normal | 0.717 | 0.289 |
| On Meds vs. Not on Meds | 0.193 | 0.608 |
| On Meds vs. No ADD/ADHD, Not on Meds | 0.465 | 0.448 |

Table 1: Variables with no statistical significance according to SPSS analysis

Interestingly, there was a statistically significant difference between males and females in average amplitude of accommodation (Sig = 0.004) and difference in expected and actual accommodative amplitudes (Sig = 0.012). In addition, there were also statistically significant differences between tight lag and loose lag groups in terms of average amplitude (Sig = 0.020) and difference in expected and actual (0.029).

| | Significance | |
|---|---|---|
| | Average Amplitude | Difference Between Actual and Expected Amplitude |
| Males vs. Females | 0.004 | 0.012 |
| Tight Lag vs. Loose Lag | 0.020 | 0.029 |

Table 2: Variables with statistical significance according to SPSS analysis

**Discussion**

Based on this retrospective chart review of children with accommodative diagnoses, 18.6% of these children were also diagnosed with either ADD or ADHD. This percentage is greater than even the high end of estimates of worldwide prevalence, which researchers believe lies somewhere between 2.2% and 17.8%.[2] However, based on analysis, it does not appear that children with ADD or ADHD have lower amplitudes of accommodation than children who also have accommodative dysfunction without attention deficits. Additionally, it does not appear that children with accommodative disorders taking ADD/ADHD medication have a significant difference in accommodative ability compared to children without medication.

The statistically significant difference in accommodative amplitude between children with tight and loose lags is as expected. Children with low amplitudes have a lack of focusing ability. It would be expected that they would be more likely to focus behind a given target. In the contrary, patients with higher amplitudes are more susceptible to accommodative spasm, leading to a tight lag in which they focus in front of a given target.

As with all studies, this survey is subject to certain limitations. Perhaps most notably, the retrospective design of this study introduces a number of sources of potential error. For example, only information included in the reviewed charts is available for compilation. In some instances, practitioners may not have inquired about the ADD/ADHD status of their patients, especially if no medication was being used to manage the condition. Additionally, the information is dependent on the reporting of the parent or patient. It is possible that information regarding a previous diagnosis of ADD or ADHD could have been withheld in an attempt to avoid any perceived stigma associated with the condition. Another limitation of this study is the lack of uniformity between practitioners in their criteria for making the diagnosis of accommodative dysfunction. It appeared that some clinicians relied on purely on amplitude of accommodation in order to make their diagnosis, while others looked more at accommodative lag, or a combination of tests. Yet another limitation of this study is the lack of a control group consisting of children not diagnosed with accommodative dysfunction. Analysis of this group would have been helpful for determining the general prevalence of accommodative dysfunction and ADD/ADHD in the population being studied. Finally, only charts that included a parent's signature authorizing that the exam record may be used for educational purposes were included in this study. It is possible that the exclusion of records not including this signature may have introduced some bias.

While this study did not reveal a correlation between ADD/ADHD medication and accommodative insufficiency, additional research in this area is still warranted. Subsequent research should ideally begin with a group of children previously diagnosed with ADD or ADHD and on medication, as well as a second group of children who have not been diagnosed with these conditions. Both of these groups should then be analyzed for any differences in accommodative function. In addition, further investigations should be performed with larger sample sizes. This would allow for stratification of the different medications to determine if any particular drug or class of drugs has an effect on accommodative performance.

The present study indicates that children diagnosed with ADD or ADHD who also have accommodative disorders tend to manifest these accommodative problems in the same manner as children without attention problems. Additional research in the future can be expected to further clarify the relationship between ADD/ADHD, pharmaceutical agents used to treat it, and accommodative dysfunction.

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