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ORIGINAL PAPER

The Relationship between Convergence Insufficiency and ADHD*

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ABSTRACT *Background*: Children being evaluated for attention deficit hyperactivity disorder (ADHD) often have an eye exam as part of their evaluation. The symptoms of convergence insufficiency (CI) can make it difficult for a student to concentrate on extended reading and overlap with those of ADHD. *Methods*: A retrospective review of 266 patients with CI presenting to an academic pediatric ophthalmology practice was performed. All patients included were diagnosed with CI by one author (DBG) and evaluated for the diagnosis of ADHD. A computerized review was also performed looking at the converse incidence of CI in patients carrying the diagnosis of ADHD. *Results*: We reviewed 266 charts of patients with CI. Twenty-six patients (9.8%) were diagnosed with ADHD at some time in their clinical course. Of the patients with ADHD and CI, 20 (76.9%) were on medication for ADHD at the time of diagnosis for CI while 6 (23.1%) were either not on medication or the medication was discontinued several months before the diagnosis of CI. The review of computer records showed a 15.9% incidence of CI in the ADHD population. *Conclusion*: We report an apparent three-fold greater incidence of ADHD among patients with CI when compared with the incidence of ADHD in the general US population (1.8–3.3%) (Leslie et al., 2004). We also note a seeming three-fold greater incidence of CI in the ADHD population. This may simply represent an association and not be a causative relationship. Until further studies are performed, however, patients diagnosed with ADHD should be evaluated to identify the small subset that may have CI – a condition that responds well to treatment at home.

KEYWORDS Convergence insufficiency; attention deficit; ADHD; asthenopia; pediatric ophthalmology

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INTRODUCTION

Attention deficit hyperactivity disorder (ADHD) is considered to be one of the most common psychiatric disorders in children and adolescents, affecting an estimated 3–5% of school-aged children in subspecialty mental health settings and 4–12% of children in community settings (Leslie et al., 2004). A diagnosis of ADHD in a child has an impact not only on the life of the child but

also on the family, the school and society as a whole (Faraone & Biederman, 1998). ADHD is a clinical diagnosis and the diagnostic criteria are based on two groups of nine symptoms each: inattention and hyperactivity-impulsivity (Dulcan, 1997). Once diagnosed, ADHD requires continuous treatment with pharmacologic or behavioral/psychosocial interventions and counseling programs in order to enable the child to function better in different aspects of life. All these entail a great amount of effort on the part of all those involved in the child's care and supervision. Thus, it is imperative that a careful and thorough clinical and psychosocial evaluation of the child be undertaken before a definitive diagnosis of ADHD is given.

For the diagnosis, a complete medical evaluation should be performed and vision or hearing deficits should be ruled out. Underlying visual or hearing problems may cause the child's academic underperformance and/or lack of concentration. Convergence insufficiency (CI) manifests itself in an inability to converge the eyes or maintain adequate binocular convergence towards a near target without undue effort (Rowe, 1997). Some of the symptoms of ADHD overlap those of convergence insufficiency. Comparing the Convergence Insufficiency Symptom Survey (Scheiman et al., 2005) with the DSM-IV criteria for ADHD, we noted that 5 of the 9 symptoms of inattention could also be applied for CI (symptoms 1, 2, 4, 6 and 8) (American Psychiatric Association, 2000). The CI Symptom Survey and the DSM-IV criteria are presented in Appendices 1 and 2. Since the symptoms can be similar, it is not hard to imagine a diagnostic confusion.

We observed in our clinic that an unusual number of children with or suspected to have ADHD also had convergence insufficiency. To the best of our knowledge, there have been no published reports regarding the specific relationship between CI and ADHD. This study was carried out to determine any correlation between the two conditions, as it is not clear if these pathologies co-exist, are inter-causal or are misdiagnosed for each other.

METHODS

For this study, a complete list of patients with the diagnosis of CI in an academic pediatric ophthalmology practice over a 5-year time frame was obtained from the UCSD Ratner Children's Eye Center's electronic patient database and a retrospective chart review was performed. All diagnoses of CI were made by one of the authors (DBG) based on near point of convergence (>6 cm), fusional amplitudes (≤15 prism-diopters at near) and symptoms (headaches, asthenopia, difficulty in reading) (Scheiman et al., 2005). Patients with a history of diagnosis of ADHD (by patient or parent report) at the time of the initial eye exam or at any time during the follow-up visits were identified. Information regarding use of medications for ADHD within the immediate period of the diagnosis of CI was also noted. Subsequently, a second review of the UCSD Medical Records' computerized database was undertaken to identify those patients diagnosed with ADHD in all UCSD medical facilities. Among these, the patients who underwent eye examinations were selected and they were screened for the diagnosis of CI.

RESULTS

Two hundred-and-sixty-six charts of patients with CI were identified and reviewed. Among these, 26 (9.8%) had a history of ADHD at the time of diagnosis for CI or at any point in time during their follow-up (Fig. 1). There were 21 (80.8%) male and 5 (19.2%) female patients in the group with ADHD. The age of these patients ranged from 6 to 51 years (mean 11.6 years). Of the patients with CI and ADHD, 20 (76.9%) were on some form of medication for ADHD at the time of diagnosis for CI. Six (23.1%) of the patients with CI and ADHD were either not on medication or the medication had been discontinued several months before the diagnosis of CI was made. The majority (17 patients, 85%) of the patients on medication were on a single drug. Twelve patients (70.6%) taking single medications were on stimulant drugs (i.e., amphetamine or methylphenidate), three (17.6%) were on serotonin reuptake inhibitors (i.e., fluoxetine, sertraline

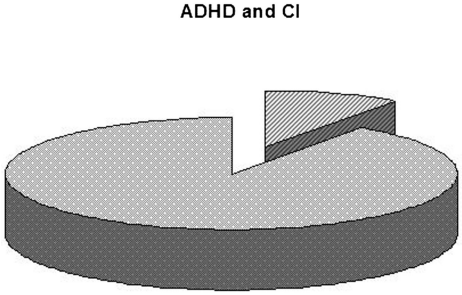

FIGURE 1

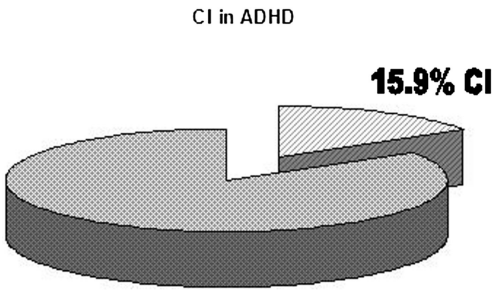

FIGURE 2

or paroxetine), one patient (5.9%) was on a tricyclic antidepressant and one (5.9%) was on clonidine.

The computerized review of the electronic database at UCSD revealed 1705 patients with the diagnosis of ADHD. Of these, 176 had eye evaluations. Twenty-eight also were coded with the diagnosis of CI - an incidence of 15.9% (Fig. 2).

DISCUSSION

The far-reaching implications of ADHD on the global functioning of the patient is of such great magnitude that much popular press and an entire volume of the Pediatric Clinics of North America have been dedicated just for the purpose of synthesizing the vast amount of research done on the nature of the disorder and the different modalities of treatment (Mercugliano, 1999). In spite of the amount of research put into the understanding of this disorder, there still is no specific diagnostic test for ADHD and the diagnosis remains essentially clinical and based on certain behavioral criteria (American Psychiatric Association, 2000; Barkley, 1998a; Connors, 1999; Hill, 1998). This diagnosis often depends largely on the inputs provided by way of questionnaires that both parents and teachers have to fill out and also by the patients themselves. Despite the popularity of these checklists, there still remains a discordance in the results obtained from the parents and teachers (or medical personnel) due to the different levels of emotional and cognitive performance of the patient in these separate settings (Morgan, 1999). But clearly, the use of both parents' and teachers' reports enhances the certainty of the diagnosis of ADHD (Biederman et al., 2004). The burden is, therefore, laid upon the clinician who needs to correlate the results of these surveys with his own clinical findings. To confound the dilemma further, several comorbid disorders may have symptoms that overlap with those manifested by patients with ADHD (Barkley, 1998b; Fletcher et al., 1999; Swanson et al., 1999) and these have to be sought out as well in order to come up with a more comprehensive management of the patient.

Part of this comprehensive evaluation is the eye exam, which is aimed at ruling out any visual problems that may be a cause of the patient's poor academic performance. We noticed a higher prevalence of ADHD in patients with CI (9.8%) as compared with the incidence of ADHD in the general US population using strict criteria (1.8–3.3%), the incidence seen in subspecialty mental health settings (estimated at 3–5% of school-aged children), and in some cases the incidence in community settings (4–12% of children) (Leslie et al., 2004). Additionally, we found at least triple the prevalence of CI in the ADHD population (15.9%) when compared to historic controls (2.25–4.2%) utilizing the computer search review of our database (Letourneau & Ducic, 1988; Rouse et al., 1999).

Convergence insufficiency causes symptoms of asthenopia, blurring of vision and the sensation that letters and words run together, especially during times of prolonged reading or near work (Blondis, 1999). Some patients report diplopia at near, nausea or occasional headaches (Von Noorden, 1996). All these symptoms become more evident in the school environment because of the increased demand for near work, thereby possibly affecting the child's academic performance. CI can be overcome with motivation and increased concentration. Many cases of CI seen in our clinic were referred due to delayed or poor reading performance or simply lagging behind in schoolwork. It seems obvious that CI could aggravate the academic performance of a patient with ADHD. Considering that CI is a treatable disorder, management with orthoptic intervention (easily at home) or, in the unusual extreme, surgery, may help the school performance of patients suffering from ADHD and CI. However, this is still unproven.

This implies the possibility of CI being a comorbid disorder in patients with ADHD, as are a host of other problems. Alternatively, it is possible that the medications used to treat ADHD are aggravating CI. For some of these drugs, difficulties with accommodation and blurring have been reported (Bennett et al., 1999). To confuse this issue further, perhaps hypertelorism and its attendant increase in interpupillary distance associated with ADHD is causing CI. Other questions are raised by this analysis, such as could the loss of concentration

seen in ADHD cause CI the way loss of concentration can cause the breakdown of an existing exophoria (Von Noorden, 1996)? Furthermore, could the poor concentration in ADHD simply worsen CI symptoms and turn an asymptomatic patient into a symptomatic one?

No matter what the true cause or cause and effect relationship, it is unavoidable that the presence of CI may cause (1) misdiagnosis, (2) diagnostic confusion or (3) exacerbation of the symptoms of ADHD. Conversely, one could also note that ADHD could (1) make the diagnosis of CI more difficult, (2) exacerbate the symptoms of CI and (3) interfere with its treatment. This would be especially true in non-academic settings where the overlap with ocular symptoms may be confusing to the non-ophthalmologist. It has been shown that when checklists of ADHD symptoms are used by non-experts, an unusually high incidence of ADHD can be demonstrated (Hill, 1998). This is likely due to overlap with other pathology that causes similar symptoms. Clearly, CI fits this category and may be an additional non-traditional confounding factor.

The limitations of our study include its retrospective nature and the fact that our study population sought medical care, so that it may potentially not reflect the real incidence of these two pathologies in the general population. ADHD diagnosis was as reported by the patient or family and is also thus less reliable. The role of medications for ADHD in the causation or aggravation of CI could not be determined in this study, so that a further investigation regarding this matter is needed. Moreover, the lack of concentration during ophthalmic testing could theoretically make it appear as if ADHD patients have CI.

We recognize the need for a prospective study evaluating the relationship between these groups. It has not escaped our attention that understanding their connection may lead to identification of CNS fusional centers and pathways as well as novel approaches to the biochemical treatment of CI. The question of whether treatment of CI would positively help the symptoms of ADHD, while apparently common sense, has not been studied and thus remains speculative.

In view of these initial findings, we believe it reasonable that CI be evaluated in patients with or suspected to have ADHD. Clearly, more study is needed before definitive recommendations can be made, no matter how intriguing the present results. We further recommend considering ADHD in patients who are referred for poor concentration, then diagnosed and treated for CI but without resolution of their symptoms.

It is important to note that this report is restricted specifically to convergence insufficiency (CI) and not the larger category of vague "eye tracking" or reading problems; the conclusions cannot and should not be generalized to these other disorders.

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APPENDIX 1
Convergence Insufficiency Symptom Survey

Clinician instructions: read the following subject instructions and then each item exactly as written. If subject responds with "yes" – please qualify with frequency choices. Do not give examples.

Subject instructions: Please answer the following questions about how your eyes feel when reading or doing close work. Please use one of the following terms:

Never (Not Very Often)
Infrequently
Sometimes Fairly Often Always

1. Do your eyes feel tired when reading or doing close work?
2. Do your eyes feel uncomfortable when reading or doing close work?
3. Do you have headaches when reading or doing close work?
4. Do you feel sleepy when reading or doing close work?
5. Do you lose concentration when reading or doing close work?
6. Do you have trouble remembering what you have read?
7. Do you have double vision when reading or doing close work?
8. Do you see the words move, jump, swim or appear to float on the page when reading or doing close work?
9. Do you feel like you read slowly?
10. Do your eyes ever hurt when reading or doing close work?
11. Do your eyes ever feel sore when reading or doing close work?
12. Do you feel a "pulling" feeling around your eyes when reading or doing close work?
13. Do you notice the words blurring or coming in and out of focus when reading or doing close work?
14. Do you lose your place while reading or doing close work?
15. Do you have to re-read the same line of words when reading?

APPENDIX 2
DSM-IV Criteria for ADHD

I. Either A or B:

A. Six or more of the following symptoms of inattention have been present for at least 6 months to a point that is disruptive and inappropriate for the developmental level:

Inattention

1. Often does not give close attention to details or makes careless mistakes in schoolwork, work, or other activities.
2. Often has trouble keeping attention on tasks or play activities.
3. Often does not seem to listen when spoken to directly.
4. Often does not follow instructions and fails to finish schoolwork, chores, or duties in the workplace (not due to oppositional behavior or failure to understand instructions).
5. Often has trouble organizing activities.
6. Often avoids, dislikes, or doesn't want to do things that take a lot of mental effort for a long period of time (such as schoolwork or homework).
7. Often loses things needed for tasks and activities (e.g. toys, school assignments, pencils, books, or tools).
8. Is often easily distracted.
9. Is often forgetful in daily activities.

B. Six or more of the following symptoms of hyperactivity-impulsivity have been present for at least 6 months to an extent that is disruptive and inappropriate for the developmental level:

Hyperactivity

1. Often fidgets with hands or feet or squirms in seat.
2. Often gets up from seat when remaining in seat is expected.
3. Often runs about or climbs when and where it is not appropriate (adolescents or adults may feel very restless).
4. Often has trouble playing or enjoying leisure activities quietly.
5. Is often "on the go" or often acts as if "driven by a motor."
6. Often talks excessively.

Impulsivity

1. Often blurts out answers before questions have been finished.
2. Often has trouble waiting one's turn.
3. Often interrupts or intrudes on others (e.g., butts into conversations or games).

II. Some symptoms that cause impairment were present before age 7 years.

III. Some impairment from the symptoms is present in two or more settings (e.g., at school/work and at home).

IV. There must be clear evidence of significant impairment in social, school, or work functioning.

V. The symptoms do not happen only during the course of a Pervasive Developmental Disorder, Schizophrenia, or other Psychotic Disorder. The symptoms are not better accounted for by another mental disorder (e.g., Mood Disorder, Anxiety Disorder, Dissociative Disorder, or a Personality Disorder).

Based on these criteria, three types of ADHD are identified:

1. ADHD, *Combined Type*: if both criteria 1A and 1B are met for the past 6 months
2. ADHD, *Predominantly Inattentive Type*: if criterion 1A is met but criterion 1B is not met for the past six months
3. ADHD, *Predominantly Hyperactive-Impulsive Type*: if Criterion 1B is met but Criterion 1A is not met for the past six months.