Dental Age Difference in Children with ADHD

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Objective: *The purpose of this study was to determine if changes in dental development are associated with Attention Deficit Hyperactivity Disorder (ADHD) or ADHD medications.* ***Study Design***: *This retrospective chart review evaluated the dental age of 128 patients between 6 and 16 years of age using the Demirjian method from the following two groups a) children with ADHD b) unaffected children. The ADHD group was further stratified into four groups according to the medication type. The impact of ADHD on dental age difference (the difference between dental age and chronologic age) was analyzed using T-test and the association between medication type and dental age difference was analyzed through one way ANOVA.* ***Results***: *The mean difference between estimated dental age and chronologic age (dental age difference) for all subjects was 0.80 years. There was no significant dental age difference in subjects with ADHD and the control group (0.78±1.28vs. 0.84 ±1.09 years respectively; P=0.75) and there was no significant difference in dental age difference and type of medication (P=0.84).* ***Conclusion***: *No significant difference was found between children with ADHD and unaffected children with respect to dental age difference. No significant differences were found in dental age difference in the four medication groups.*

Key words: *ADHD, dental age,*

INTRODUCTION

Attention-deficit/hyperactivity disorder (ADHD) is the most common childhood-onset neurobehavioral disorder, with a worldwide pooled prevalence of 5.3%.[1] It is characterized by developmentally unsuitable levels of inattention and/or hyperactivity–impulsivity that have been persistently present since age seven.[2] Multiple factors including genetics, environmental factors (e.g., lead exposure and alcohol consumption during pregnancy), brain injuries, and the social environment have been suggested as underlying causes of ADHD.[3-8] Most children being treated for ADHD are managed with a combination of behavioral and pharmacologic therapies and current drugs employed in the treatment include stimulants and non-stimulants.[9,10] The exact mechanism by which these medications reduce ADHD symptoms is not fully known.[9,10] They are thought to alleviate symptoms of ADHD through similar neurochemical actions i.e. by enhancing the synaptic levels of monoamines in the brain, but with different selectivity and molecular mechanisms.[11]

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There is a controversy in the literature with regards to ADHD and its effect on somatic growth. Changes in somatic growth and development observed in children with ADHD may be associated with developmental changes probably due to biochemical, endocrinological, neurological, and neuroanatomical differences from unaffected children.[4-8,12,13]

Growth depression of hyperactive children taking stimulant drugs was initially reported in an early study in 1970s and was later supported by Loney et al. and Mattes and Gittelman.[14-17] Safer et al. found that children with delayed weight gain also had a proportional delay in height.[14] The changes in growth and development have often been described in association with medications.[12,13] Data from the 3-year follow-up of the Multimodal Treatment of ADHD study showed that stimulant use was associated with a significant reduction in growth velocity during the first year of treatment.[18,19] However, by the third year growth rates were the same in the stimulant-treated and non-stimulant treated groups, although those treated with stimulants continued to be shorter and lighter overall.[19] In contrast no long term impact on height was noted in another study and also different stimulant medication did not differ in their effect on growth.[13] It has also been proposed that growth deficit in children with ADHD during pharmacologic treatment can be a manifestation of the disorder itself and not a side effect of the medication.[20]

Harstad *et al* determined in a longitudinal, population-based study that ADHD or treatment with stimulants is associated with significant deficits in height in adulthood.[21] However the study did find male subjects achieved peak height velocity significantly later if they had been treated with stimulants for at least 3 months compared with

stimulant-naïve cases.[21] They also found a positive correlation between the duration of stimulant usage and the age of peak height velocity.[21]

The effect of ADHD on dental development has not been extensively investigated. Distinct disparities in physical and dental development were found between two groups of boys in a private and therapeutic school composed of children with the following specific learning disabilities: dyslexia, dysgraphia, ADHD, and severe speech impairments.[22] The authors suggested the findings may be due to differences in socioeconomic status of the children but also pointed out the previous studies did not find dental development to be related to different socioeconomic backgrounds.[22] In another study, the effect of chronic methylphenidate administration was investigated on tooth maturation in a sample of Caucasian children.[23] Authors found that children, who ingested an average dose of 30 mg of methylphenidate daily for a mean duration of 54 months showed no delay in dental maturation.[23]

Therefore the purpose of this investigation was to determine 1) if ADHD diagnosis impacts dental age and 2) if type of ADHD medication affects dental age. The authors hypothesize ADHD diagnosis and type of medication will have no effect on dental age.

MATERIALS AND METHOD

This research was approved by the Louisiana State University Health Sciences Center Institutional Review Board (IRB #8547).

Charts of patients aged 6 and 16 years with a history of treatment in the Department of Pediatric Dentistry at the Louisiana State University School of Dentistry and a private orthodontic office in New Orleans were reviewed. The sample size was determined by a power analysis based on the data collected by Batterson et. al.[23] At least 71 patients per group were needed to achieve a power of 80% and to detect a difference of 0.4 between the groups. In the power analysis, it was assumed that the mean of the control group was 0.97 with a standard deviation of 0.8. The significance level (alpha) was set at 0.05 using a two-sided, two-sample t-test.

Charts of patients with a diagnostic panoramic film were reviewed to identify the following two groups: a) children who have been diagnosed with ADHD b) unaffected children. Charts were excluded from review if the patients had multiple congenitally missing teeth or a history of chronic infectious disease, nutritional disturbances, endocrine disorders, or any other neurobehavioral disorder. Patients were sex and age-matched utilizing the following three age groups: a) 6-10 years, b) 11-12 years, and c) 13-16 years.

Children diagnosed with ADHD were stratified on the basis of medications they were taking or had taken. The four groups according to the type of medications were a) Group 1–Non stimulants, b) Group 2–Methylphenidate stimulants, c) Group 3–Amphetamine stimulant, d) Group 4–Blood pressure medications such as Clonidine.

Prior to commencing the study, the primary investigator and a faculty investigator analyzed the dental age difference for five children independently to calibrate the primary investigator. Patients' dental age was determined by a single primary investigator using the method described by Demirjian in 1973.[24,25] In this method, examination of the seven left permanent mandibular teeth on panoramic radiographs are used to assess dental development. Tooth development is divided into 8 stages of calcification (A to H) and the criteria for the stages are given for each tooth with detailed written and supplemental illustrations and the teeth are categorized by tooth development. Each stage of the 7 teeth is given a score using methods similar to those used for assessment of skeletal maturity.[26] Separate standards are used for each sex. The sum of the scores (maturity score) for the 7 teeth is converted to a dental age by using the table provided in the study.[24,25]

Subjects' dental age difference was calculated by subtracting the chronological age from the calculated dental age. Positive difference reflect acceleration, and negative difference reflect a delay in dental development.

Dental age difference (difference between chronologic age and dental age) was analyzed in the two groups using a t-test. One-way ANOVA was used to analyze the association between dental age difference and medication type. The level of significance was set at $P<0.05$. To determine intrarater reliability, ten panoramic radiographs were reassessed after two weeks and dental ages were compared using Cronbach's alpha.

RESULTS

One hundred twenty-eight subjects (64 males and 64 females) met the inclusion criteria and were included in the study. Seventy-six patients with ADHD and 52 control patients were included in the analysis. The average chronologic age was 10.4 ± 2.4 years and ages ranged from 5.3 to 16.8 years and dental ages ranged from 7.2 to 16 years. The mean chronologic age for patients with ADHD and the control patients was 10.9 ± 2.4 and 9.7 ± 2.2 years respectively as shown in Tables 1 and 2.

The mean difference between estimated dental age and chronologic age or dental age difference for all subjects was 0.80 ± 1.2 years as shown in Figure 1. Mean differences in dental ages were 0.78 ± 1.3 and 0.84 ± 1.1 years for ADHD and control subjects respectively. Dental age differences were not significantly different in ADHD and unaffected children (P=0.78).

Of the 72 patients with ADHD, 42.8% were not taking medication, 51.9% were taking one medication, and 5.3% were taking 2 medications. The majority of patients were taking amphetamine stimulants (54.0%), followed by methylphenidate stimulants (36.5%), and then non-stimulants (7.4%). Only one patient was taking a blood pressure medication. When dental age difference was compared in the four medication groups, no statistically significant difference was observed (P=0.84).

There was no significant association between sex and ADHD (P=0.60), nor was a significant difference was found in dental age when the samples was stratified by males and females (P= 0.92 and P=0.67, respectively).

A high degree of consistency was observed in evaluation of intraexaminer variability. Cronbach's alpha was 0.99 for measuring dental ages for the repeated 10 panoramic radiographs.

Figure 1. This graph depicts the mean dental age difference in years between children with ADHD and unaffected controls.

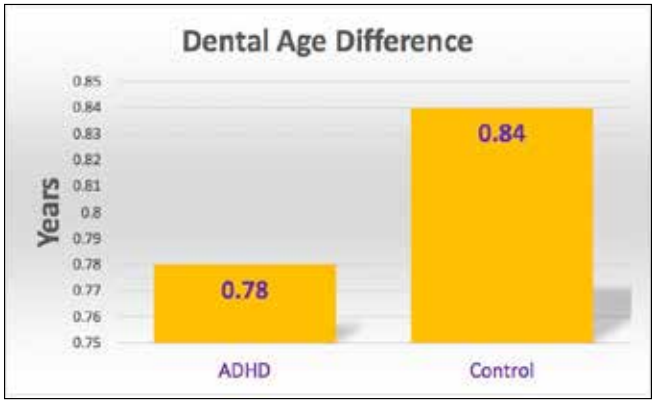

Table 1. Age and Gender Distribution and Exposure Data for Control Group

	N	Mean	SD	Minimum	Maximum
Age (years)	52	9.72	2.23	5.35	14.30
Female	29	9.72	1.95	6.70	13.70
Male	23	9.72	2.60	5.35	14.30
Dental Age (years)	52	10.57	2.31	7.20	15.80
Female	29	10.66	2.22	7.20	14.60
Male	23	10.45	2.46	7.30	15.80

Table 2. Age and Gender Distribution and Exposure Data for ADHD Group

	N	Mean	SD	Minimum	Maximum
Age (years)	76	10.91	2.41	6.11	16.80
Female	35	11.01	2.46	6.70	16.80
Male	41	10.82	2.39	6.11	16.19
Dental Age (years)	76	11.69	2.41	7.60	16.00
Female	35	11.81	2.42	8.20	16.00
Male	41	11.58	2.42	7.60	16.00

DISCUSSION

This study did not find that diagnosis of ADHD or medication type significantly impacted dental maturation. The dental development in ADHD children was slightly delayed compared to the control but no statistically significant difference was found. This is in disagreement with Lysiak-Seichter et. al., who found dental age development to be accelerated in boys attending a therapeutic school for specific learning disabilities like dyslexia, dysgraphia, ADHD or severe speech disorder, although the difference was not statistically significant.[21] Likewise, a study evaluating the effect of chronic use of methylphenidate hydrochloride medication on dental maturation did not find any significant delay in dental maturation.[23] Although the findings of this study agree with the present investigation, it is noteworthy that the former only evaluated the effect of stimulants drugs on dental maturation.[23] Stratification of the sample by sex did not yield statistically significant findings.

The effect of ADHD, with and without pharmacologic treatment, on somatic growth has been widely studied; however, there is a paucity of studies where dental development has been evaluated. Considering the prevalence of this disorder and the daily interaction of children with ADHD with pediatric dentists and orthodontists, understanding the dental development in this group is important. Pessah et al. highlighted therapeutic difficulties (behavior, attention span, cooperation, hygiene, and dental trauma) of children with ADHD during orthodontic treatment.[27] Additional information about the dental development of this population will lead to relevant modification of orthodontic treatment plans accommodating the expected changes in dental age development as compared to children without this disorder. This study concludes that ADHD does not impact dental development and does not need special consideration in regards to timing.

The Demirjian method, used to determine dental age, is considered highly accurate and is one of the most frequently used systems. The data is derived from 5,447 panoramic radiographs from a French-Canadian mixed sample of girls and boys between the ages of 2.5 and 19 years. It is less accurate than skeletal, somatic, or sexual indicators with peak height velocity[28], but this method is currently accepted for US children. [29] In a study conducted on 946 children of two ethnicities, British Caucasian and Bangladeshi, accuracy of age estimation of three radiographic methods Demirijian (Willems-adjusted scores), Nolla, and Haavikko showed Willems-adjusted data for Demirijian to be the most accurate method in estimating age in that sample. [30] Tooth formation described by Demirjian was the easiest and clearest method of stage assessment, although the Kappa value was similar to Haavikko's stages. [30]

The strength of this investigation is the sample size that exceeded the sample size of a previous similar study[23] and the sample size suggested after the power analysis. In addition, this is the first investigation where role of different types of medication on dental development has been evaluated.

The present study have several limitations. Duration of medication intake in ADHD group could not be considered because of the retrospective nature of the study. Also there may be many other known variables such as body mass index or ethnicity that may affect the dental development. The unavailability of data in some of the included patient charts limited the inclusion of these variables in the present investigation. Similarly the number of children taking nonstimulant medications and blood pressure medications was low. Future prospective studies that take these variables into account are needed to definitively conclude that there is no association with ADHD or medication type with dental maturation.

CONCLUSIONS

Data from this study found no significant difference in dental age in children with ADHD compared to unaffected children. The dental age difference was not statistically different in 4 groups of medication in ADHD children.

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REFERENCES

1. Polanczyk G, de Lima MS, Horta BL, Biederman J, Rohde LA. The worldwide prevalence of ADHD: a systematic review and meta-regression analysis. Am J Psychiatry; 164:942–8. 2007.
2. American Psychiatric Association. *Diagnostic and statistical manual of mental disorders: DSM-5*. 5th ed. Arlington, VA: American Psychiatric Association; 2013.
3. Akutagava-Martins GC, Salatino-Oliveira A, KielingCC, Rohde LA, Hutz MH. Genetics of attentiondeficit/hyperactivity disorder: current finding andfuture directions. Expert Rev Neurother; 13:435-45. 2013.
4. Paclt I, Koudelova J, Krepelova A, Uhikova P, Gazdikova M, Bauer P. Biochemical markers and geneticresearch of ADHD. Neuro Endocrinol Lett; 26: 423–30. 2005.
5. Kariyawasam SH, Zaw F, Handley SL. Reduced salivary cortisol in children with comorbid Attention deficit hyperactivity disorder and oppositional defiant disorder. Neuro Endocrinol Lett.; 23: 45–8. 2002.
6. Kopeckova M, Paclt I, Petrasek J, Pacltova D, Malikova M, Zagatova V. Some ADHD polymorphisms (ingenes DAT1, DRD2, DRD3, DBH, 5-HTT) in case-control study of 100 subjects 6–10 age. Neuro Endocrinol Lett.; 29: 246–51. 2008.
7. Schubiner H, Katragadda S. Overview of epidemiology, clinical features, genetics, neurobiology, and prognosis of adolescent attention-deficit/hyperactivity disorder. Adolesc Med State Art Rev; 19: 209–15. 2008.
8. Garrett A, Penniman L, Epstein JN, Casey BJ, Hinshaw SP, Glover G, Tonev S, Vitolo A, Davidson M, Spicer J, Greenhill LL, Reiss AL. Neuroanatomical abnormalities in adolescents with attention-deficit/hyperactivity disorder. J Am Acad Child Adolesc Psychiatry; 47: 1321–8. 2008.
9. Wilens TE. Effects of methylphenidate on the catecholaminergic system in attention-deficit/hyperactivity disorder. J Clin Psychopharmacol; 28(3 Suppl 2): S46-53. 2008.
10. Hodgkins P, Shaw M, McCarthy S, et al. The pharmacology and clinical outcomes of amphetamines to treat ADHD: does composition matter? CNS Drugs;26:245-68. 2012.
11. Yi F, Liu SS, Luo F, Zhang XH, Li BM. Signaling mechanism underlying alpha2A-adrenergic suppression of excitatory synaptic transmission in the medial prefrontal cortex of rats. Eur J Neurosci; 38: 2364-73. 2013.
12. Zachor DA, Roberts AW, Hodgens JB, Isaacs JS, Merrick J. Effect of long-term psychostimulant medication on growth of children with ADHD. Res Dev Disabil; 27: 162–74. 2006.
13. Hrdlicka M, Zedkova I, Blatny M, Urbanek T. Weight gain associated with atypical and typical antipsychotics during treatment of adolescentschizophrenic psychoses: A retrospective study. Neuro Endocrinol Lett; 30: 256–61. 2009.
14. Safer D, Allen R, Barr E. Depression of growth in hyperactive children on stimulant drugs. N Engl J Med; 287:217-30. 1972.
15. Safer DJ, Allen RP. Factors influencing the suppressant effects of twostimulant drugs on the growth of hyperactive children. Pediatrics;51:660-7. 1973.
16. Safer DJ, Allen RP, Barr E. Growth rebound after termination ofstimulant drugs. J Pediatrics;86:113-6. 1975.
17. Mattes JA, Gittelman R. Growth of hyperactive children on maintenanceregimen of methylphenidate. Arch Gen Psychiatry;40:317-21. 1983.
18. Sujlana A, Dang R. Dental care for children with attention deficit hyperactivity disorder. J Dent Child;80(2):67-70. 2013.
19. Faraone SV, Biederman J, Morley CP, Spencer TJ. Effect of stimulants on height and weight: a review of the literature. J Am Acad Child Adolesc Psychiatry; 47:994–1009. 2008.
20. Spencer T, Biederman J, Wilens T. Growth deficits in children with attentiondeficit hyperactivity disorder. Pediatrics; 102: 501–6. 1998.
21. Harstad EB, Weaver AL, Katusik S, et al. ADHD, stimulant treatment, and growth: a longitudinal study. Pediatrics;134:e935-3944. 2014.
22. Lysiak-Seichter M, Gredes M, Proff P, Gedrange T, Splieth CH. Evaluation of disparities in physical development and dental age of two specific groups of boys. Eur J Paediatr Dent.; 7:169-73. 2006.
23. Batterson KD, Southard KA, Dawson DV, Staley RN, Qian F, Slayton RL. The effect of chronic methylphenidate administration on tooth maturation in a sample of Caucasian children. Pediatr Dent.; 27:292-7. 2005.
24. Demirjian A, Buschang PH, Tanguay R, PattersonDK. Interrelationships among measures of somatic, skeletal, dental, and sexual maturity. Am J Orthod; 88:433-8. 1985.
25. Demirjian A, Goldstein H, Tanner JM. A new system of dental age assessment. Human Biol; 45:211-227. 1973.
26. Tanner JM, Whitehouse RH, Marshall WA, Healy MJR, Goldstein H. Assessment of Skeletal Maturity andPrediction of Adult Height (TW2 Method).London, England: Academic Press; 1975.
27. Pessah S, Montluc N, Bailleul-Forestier I, Decosse MH.Orthodontic treatment of children suffering from attention deficit disorder with hyperactivity (ADHD).See comment in PubMed Commons belowOrthod Fr.;80:331-8. 2009.
28. Eid RM, Simi R, Friggi MN, Fisberg M. Assessment of dental maturity of Brazilian children aged 6 to 14 years using Demirjian's method. Int J Paediatr Dent; 12:423-8. 2002.
29. Hilgers KK, Akridge M, Scheetz JP, Kinane, D. Childhood Obesity and Dental Development. Pediatr Dent;28:18-22. 2006.
29. Maber M, Liversidge HM, Hector MP. Accuracy of age estimation of radiographic methods using developing teeth. Forensic Sci Int; 159 Suppl 1:268-73. 2006.