



Attention Deficit-hyperactivity Disorder in Children: Diagnostic Method and Comparison with Healthy Children

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ABSTRACT

Attention deficit-hyperactivity disorder (ADHD) is one of the most common psychiatric disorders among children. It is associated with adverse complications for the children, their families, and the society in both short and long runs; therefore, finding solutions to correctly and timely diagnose the disease brings about numerous benefits. In this regard, the present study was carried out in order to examine the mean scores of neurological soft signs as a tool for more accurate and faster diagnosis among children with ADHD and compare them with healthy children. The present study was a descriptive analytical cross-sectional investigation that was carried out in Child and Adolescent Psychiatry Clinic, Imam Hussein Hospital. Twenty-five children aging 7-12 with ADHD were examined using attention deficit-hyperactivity checklist of DSM-IV, Conners Test, and 28-item Neurological Evaluation Scale (NES) (to examine neurological soft signs). Afterwards, the results were compared with those of 25 children without the disorder. The children with ADHD were all treated with Ritalin. The total scores in NES in the experimental group and the control group were respectively 11.4 ± 4.14 and 5.6 ± 79.2 , and this difference was completely significant ($P > 0.0001$). The experimental group obtained higher scores in glabellar reflex, quick alternative movements, and right-left separation compared to the control group. Given the significant difference between the children with ADHD and the healthy ones, these signs can probably be used to early diagnose the disorder and take faster steps toward preventing and treating it.

Keywords: Attention Deficit-Hyperactivity Disorder, Soft Signs

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Introduction

Attention deficit hyperactivity is the most common developmental disorder in childhood and adulthood and affects about 3-5% of the

children before the age of 7. The degree of its prevalence is 2-10% and even more among American children (Pasquale and Thomas, 2000).

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Attention deficit-hyperactivity disorder (ADHD) is a disorder in which there are hyperactivity, negligence, and more extremely sudden behaviors compared to other children, and it is one of the main causes of the children's referral to mental health service centers in 30-50% of the cases (Jonathan and Pincus, 2002; Sadock and Sadock, 2003).

In spite of its high prevalence and investigations into it over 40 years, diagnostic criteria are still completely behavioral and the certain cause and underlying pathology of this disorder have not been known yet, as a result it is less possible to prevent it with the aim of reducing risk factors (NIMH, 1998). In general, the proposed causes of this disorder vary a lot and include factors related to family and genetics, embryonic and postpartum issues, effects caused by toxic chemicals, psychosocial stresses, and abnormalities in brain structure and function (Jensen, 2002). In any case, the most important point is the heterogeneity of the disorder (Sadock and Sadock, 2003). According to the numerous complications of this disorder for children, their families, and the society in the long and short runs, early diagnosis and timely treatment are highly significant. The term "neurological soft signs" was first used in the 1940s by Lourta Bandar to describe some neurological deficits in children with schizophrenia. These signs do not indicate neurological disorder in a specific area of the brain, but they include some types of deficits such as dysfunction in sensory integration, motor coordination, or tasks of sequential movements, and they are related to an increase in genetic vulnerability, poor pre-disease adaptation, early onset of disorder, and prognosis in schizophrenia (Bombin 2003; Heinrichs and Buchanan, 1998). Some of these signs are developmental and are considered natural in a specific age group. Other signs are related to inherited conditions and diseases. In fact, some researchers believe that the term neurological soft signs refer to minor brain damage. Among types that have been observed while examining patients are behaviors such as hyperactivity, impulsivity, short attention field, and emotional fluctuations (Fellick *et al.*, 2002). Moreover, it has been proposed that neurological soft signs are associated with certain genes, and if this issue is proved, vulnerable individuals at risk can be diagnosed

early by knowing vulnerable genes and using genetics, and early diagnosis and prevention can be facilitated. There are contradictions in scientific texts regarding neurological soft signs in ADHD. Wikler *et al.*, (1970) and Camp *et al.*, (1978) reported no difference in prevalence of neurological soft signs among children with ADHD and the control children (Jonathan and Pincus, 2002). In the study carried out by Nicholas and Chen, slight degrees of hyperactivity and attention deficit were found in the children with neurological soft signs. Shaffer *et al.*, (1985) found no relationship between early neurological soft signs and attention deficit and conduct disorder in 63 male and 27 female adolescents who had developed neurological soft signs at the age of 7. In this group; however, the three related signs (i.e. slow motion, uncertain movements, and dysgraphesthesia) were related to low intelligence scores and low attention field (Jonathan and Pincus, 2002). In the study conducted by Castellanos *et al.*, 2000 abnormal performance of frontal oculomotor was reported in girls with ADHD. In addition, Lucas (1965), Mickelson (1982), and McMahon and Greenberg (1977) reported that neurological soft signs were more common in younger children with ADHD than the control group (Jonathan and Pincus, 2002). In their study on children of 2-4 years old, Orney *et al* concluded that neurological soft signs associated with hyperactivity, attention deficit, and delay in speaking are probably the signs of early clinical symptoms of ADHD, and 80% of the children with such signs develop this disorder during the first years of school (8). In their study aimed at examining the rate of prevalence and mean score of neurological soft signs in children with ADHD and their siblings and comparing it with a healthy population, Razjooyan *et al* reported that prevalence of neurological soft signs among the siblings of children with ADHD was higher than the control group. Given the mentioned contradictions and lack of similar studies in Iran, the present study was carried out in order to examine the difference in mean scores of neurological soft signs prevalence among children with ADHD in comparison with a healthy control group.

Methods

The present study was a descriptive-analytical cross-sectional study in which 25 children with



an age range of 7-12 who had referred to Child and Adolescent Psychiatry Clinic, Imam Hussein Hospital and were diagnosed with ADHD through the descriptions taken from the parents, examination, clinical observations, Conners parent structured test, and ADHD checklist conducted by two pediatric psychiatrist were assigned in the experimental group. And 25 children who did not have the disorder based on the mentioned tools were assigned in the control group. The experimental children were all treated with Ritalin.

Children with mental retardation (IQ<70), Tourette disorder, chronic tick disorder, compulsive obsessive-compulsive disorder, cerebral palsy, and any apparent neurological disorder that would disrupt the results of the study were excluded from the study. Afterwards, they were examined using Neurological Evaluation Scale (NES). The twenty-five control children who were in the age range of 7-12 and of both male and female genders were examined using NES after consent letter was obtained from their parents, and Conners parent structured test and DSM-VI questionnaire proved that they did not suffer ADHD. This test includes 28 neurological soft signs each of which receives a score of 0, 1, or 2. The minimum score is 0 and the maximum is 84. The collected data were analyzed using SPSS 13.0 Software, and the mean scores of NES were first totally and then specifically calculated for each of the 28 signs in the two groups, and the means of the two groups were compared using Independent T-test.

Results

In the present study, 25 children (50%) were in the hyperactive group and 25 (50%) in the control group, and 66% were male and 34% were female. Fourteen children in the control group and 19 in the experimental group were male, and the two groups were not significantly different in this regard.

The mean age in the experimental group was 10.16 ± 1.51 and in the control group 9.56 ± 1.89 ; however, this difference was not significant (See Table 1). Evaluation of neurological soft signs (NSS) showed a total NSS score of 11.4 ± 4.14 in the experimental group and 5.6 ± 2.79 in the control group, which was a significant difference ($P < 0.0001$).

Comparing the 28 neurological soft signs led to the following results. There was no significant difference between the two groups in the tests of tandem walk, adventitious overflow, tremor, dominance, hemispheres, audio-visual coordination, Ozeretski test, 5- and 10-minute memory test, 1st and 2nd part rhythm tapping, extinction, convergence, gaze impersistence, finger to nose, grasp reflex. In Romberg test, snout reflex and suck reflex did not have any problems in any of the groups. In streognosis and graphetesia tests, fist-ring test, fist-edge-palm test, rapid alternative movements, finger-thumb movements, mirror movements, right-left separation, synkinesis, and glabellar reflex, there was no significant difference between the hyperactive group and the control group. This difference was specifically significant regarding glabellar reflex, rapid alternative movements, and right-left separation ($P < 0.0001$).

Discussion

The results of the present study showed that neurological soft signs were significantly more among children with ADHD than the control group, and this difference is completely visible in some of the signs. The present study is in line with the studies carried out by Lucas (1965), Mickelson (1982), and McMahon and Greenberg who reported a generally higher rate of neurological soft signs among children with ADHD compared to control groups. In addition, the results of the study conducted by McMahon and Greenberg showed no relationship between treatment with the afflicted children's response. The present study; however, was not in line with the study conducted by Shaffer *et al.*, 2000 in which there was no relationship between early neurological soft signs and ADHD and conduct disorder. The results of the study carried out by Shaffer *et al.*, 2000; however, showed a relationship between the three signs of slow motion, uncertain movements, and dysgraphesthesia and low intelligence and poor attention field. In the studies carried out by Wikler *et al.*, (1970) and Camp *et al.*, (1978), no difference was observed between the children with ADHD and healthy ones in terms of prevalence of the signs. In those studies; however, none of the neurological soft signs was solely examined. In the study conducted by Nicholas and Chen (1981) on 7-year-old children, the results showed that neurological

soft signs were just slightly more in the children with ADHD than the control group.

Since the neurological soft signs and initial reflexes naturally exist at early ages, all children around the age at which it seems that developmental issues fade away (over the age of 6 years, 11 months, and 30 days) were included in the study. According to the results of the present study, it seems that these signs are more stable in children with ADHD and extend to natural developmental age. In the present study, the children with ADHD had more problems in all three categories of sensory integration (e.g. right-left separation), motor coordination (e.g. rapid alternative movements, and tasks of sequential movements (e.g. fist-edge-ring test and fist-palm test) compared to the control group.

Compared to the control group; however, the children with ADHD had a higher mean score in

mirror movements that are not placed in a special category. Despite the results reported by Lerer *et al* on the effect of Ritalin on neurological signs, they reported 5.72% visible improvement or complete disappearance of the signs after the treatment with Ritalin. In this study, all of the children with ADHD were treated with Ritalin, but they still had higher mean scores of neurological soft signs (in line with the study carried out by McMahon and Greenberg). Therefore, Ritalin does not seem to be able to remove the difference between the experimental and control groups, and the experimental group will still have a worse condition. In comparing previous studies that are in line with the present study, they are in agreement regarding the difference in mirror movements and right-left separation, but none of them referred to significant difference in terms of rapid alternative movements and glabellar reflex.

Table 1. The statistical specifications of neurological soft signs form in the patient and control groups

| Variable | Experimental | Control | P-value |
|----------------------------|--------------|-----------|---------|
| | Mean±SD | Mean±SD | |
| Tandem walk | 0.12±0.43 | 0±0 | 1.3 |
| Romberg test | 0±0 | 0±0 | - |
| Adventitious over | 0.08±0.27 | 0±0 | 1.4 |
| Tremor | 0.04±0.2 | 0±0 | 1 |
| Cerebral dominance | 0.4±0.64 | 0.44±0.71 | 0.2 |
| Audio-visual integration | 0.36±0.63 | 0.16±0.37 | 1.3 |
| Streognosis | 0.12±0.33 | 0±0 | <0.01 |
| Graphetisia | 0.64±0.81 | 0.16±0.47 | <0.01 |
| Fist-ring test | 0.88±0.83 | 0.40±0.57 | <0.01 |
| Fist-edge-palm test | 1.08±0.64 | 0.68±0.69 | <0.01 |
| Ozeretski test | 1.44±0.76 | 0.24±0.92 | 0.8 |
| Memory (5 min) | 0.20±0.57 | 0.08±0.27 | 0.9 |
| Memory (10 min) | 0.12±0.43 | 0±0 | 1.3 |
| Rhythm tap (A) | 0.16±0.47 | 0.28±0.67 | 0.7 |
| Rhythm tap (B) | 0.52±0.77 | 0.24±0.59 | 1.4 |
| Rapid alternative movement | 0.44±0.65 | 0±0 | <0.001 |
| Finger-thumb opposition | 0.24±0.43 | 0.04±0.2 | <0.01 |
| Mirror movement | 1.08±0.7 | 0.6±0.57 | <0.01 |
| Extinction | 0.32±0.69 | 0.12±0.43 | 1.2 |
| Right-left confusion | 0.8±0.91 | 0.2±0.57 | <0.001 |
| Synkinesis | 0.52±0.71 | 0.12±0.33 | <0.01 |
| Convergence | 0.36±0.7 | 0.24±0.59 | 0.6 |
| Gaze impersistence | 0.24±0.52 | 0.20±0.57 | 0.25 |
| Finger to nose test | 0.08±0.27 | 0±0 | 1.4 |
| Glabellar Test | 1.12±0.92 | 0.4±0.7 | <0.001 |
| Snout Reflex | 0±0 | 0±0 | - |
| Grasp Reflex | 0.08±0.27 | 0.04±0.2 | 0.58 |
| Suck Reflex | 0±0 | 0±0 | - |
| Total NSS | 11.4±4.14 | 5.6±2.8 | <0.0001 |



Particularly, glabellar reflex that is considered as an initial reflex and among clinical diagnostic tests in schizophrenia (increase in reflex) or drug side effects (decreased reflex) is the result of high dopamine, and disturbance in it is regarded as disturbance in frontal lobe, and these two prove underlying pathogenesis in attention deficit hyperactivity disorder (being hyperdominergic and involvement of frontal lobe permotor area which causes change in behavior, attention field, and personality without clear involvement in major motor signs, disorder in reading and writing and math or decline in IQ). Here, five major questions are posed:

1. Are neurological soft signs a developmental issue and naturally found in all children? Is the only difference of ADHD children with others that these signs are more stable in them? Will these signs disappear in such children at higher ages compared to other children (such as underlying pathology in urinary incontinence in children)? Or is it not a developmental issue and should it be treated as a pathological issue from the beginning?
2. Are neurological soft signs acquirable and the symptoms of brain damage, among which are hyperactivity, attention deficit, and impulsivity? Or are they congenital and do they have roots in the child's genetics?
3. Are these signs an indication for hereditary and genetic disorders and are transferred as trait markers in risk families and are children with such signs at higher risk of developing such disorders?
4. If these signs are a real indication for brain dysfunction, can we refer to them as soft signs or should we treat them more seriously?
5. Since many pathologic neurological signs may exist at a time of disease and fade away at another time (such as epileptic seizure attacks), is existence of these signs natural during childhood? Or should we pay more attention to them?

Conclusion

According to the results of the present study, it seems that presence of neurological soft signs can be an indication for risk factors in high risk children or among diagnostic signs in children suspected of having low attention deficit hyperactivity disorder. On the other hand, given

the effect of early intervention on reducing the complications caused by the disease in the high risk group (like the children of parents with ADHD or the afflicted children's siblings), these signs can be used to prevent the disease and provide faster treatment. At the same time, it should be noted that these signs do not seem to exist for specific ADHD such as reports on their presence in schizophrenia, adolescent mania, and obsessive-compulsive disorder in children. According to this issue, this question comes to mind "Are these signs an indication for vulnerability common among these syndromes, or is it completely accidental? And is there a special sign that can precisely distinguish these syndromes?" This issue needs further investigations.

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