Clinical Research

Ayurvedic approach for improving reaction time of attention deficit hyperactivity disorder affected children

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Abstract

Attention deficit/hyperactivity disorder (ADHD) is a behavioral disorder of children. It is the most common neurological disorder of childhood. The present study was conducted to examine the increase in attention span in 43 ADHD-affected children treated with different approaches. The reaction time was measured using a Vernier chronoscope (electronic). Selected children of both sexes in the age-group of 6–16 years were divided into three groups. In group A, 17 patients received syrup Ayurvedic compound I; in group B, 14 patients were treated with syrup Ayurvedic compound I + Shirodhara with milk; and in group C, 12 patients received syrup Ayurvedic compound II (placebo). The dose of the drug was 1.0 ml/kg body weight and the duration of treatment was 3 months. Group B showed highly significant (P<.001) improvement in total reaction time, while in group C the change was statistically nonsignificant P > 0.10. It was found that while the drug and Shirodhara were both effective in improving the reaction time of ADHD-affected children, the drug combined with Shirodhara was superior to the drug used alone.

Key words: ADHD, Vernier chronoscope, reaction time (RT), Shirodhara

Introduction

As modern medicine has failed to provide a cure for a variety of health problems, more and more people are turning to the alternative and complementary medical sciences, especially Ayurveda, in search of relief. Among the problems for which modern medicine has failed to find a solution are the behavioral or psychiatric disorders of childhood. Many of these problems are of a transient nature and often go unnoticed. However, attention deficit/hyperactivity disorder (ADHD) is a behavioral disorder of children that comprises perhaps 50% of referrals to child neurologists, behavioral pediatricians, and child psychiatrists. It is characterized by inattention, with increased distractibility and difficulty in sustaining attention, poor impulse control, and decreased self-inhibitory capacity, as well as motor overactivity and motor restlessness.[1,2] The incidence of ADHD in school-going children in the West and India ranges from 5%–10%.[3] Two to four times more boys than girls are affected.[4,5] It often continues into adolescence and adulthood and can cause a lifetime of frustrated dreams and emotional pain.

A number of researches show that children with ADHD have slower reaction times or attention span than the general population.[6,7] Reaction time is the time from the onset of a stimulus to the time the organism responds. The cerebellum is one of the areas of the brain concerned with making quick responses and so a poor reaction time is consistent with the theory that a weak or underdeveloped cerebellum is partly to blame.

Reaction time is determined by modality and summation of stimulus, foreperiod and preparatory set, motivation, sensory and motor attitudes, individual differences, fluctuation of attention, fatigue, use of drugs, practice, age, sex, intelligence, finger tremors, left vs right hand, vision (direct vs peripheral), sobriety, breathing cycle, and intake of stimulant drugs (e.g., caffeine).

Essentially, the faster one processes information coming into the brain, the more information one has at one’s disposal to make a decision. Imagine filling a bottle with water from a tap; how fast you can fill the bottle depends on how fast the water comes out of the tap and how wide the neck of the bottle is. This analogy holds true in the case of the role of the cerebellum in ADHD. A lot of sensory information pours into the cerebellum, and when the cerebellum is immature it acts as a bottleneck. Any sensory input that cannot be coped with by the cerebellum will be discarded rather than be processed. So when a child with ADHD does not hear your instructions, it may be that the sounds were ‘heard’ but were discarded before the signals reached the consciousness and the processing parts of the brain.

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In view of the poor outcomes of ADHD-affected children, we studied a herbal drug compound and Shirodhara for their abilities to improve the reaction time in ADHD and also to achieve a homeostasis of the vitiated Doshas in the affected child.

Material and Methods

The present study was conducted to examine the efficacy of an Ayurvedic compound in decreasing reaction time in ADHD-affected children, using the Vernier chronoscope (electronic) test.

For this study, we selected all affected children attending the OPD of the Department of Bal Roga, National Institute of Ayurveda, Jaipur, and also screened the students of the schools in the area around the National Institute of Ayurveda to identify cases. Only children between 6 to 16 years were included in the study. In all, from the above-mentioned sources, 70 children were identified as eligible for inclusion in the study. Out of these, 55 children were registered; 12 children discontinued the treatment during the course of the study.

The selected patients were randomly divided into three groups, ensuring all the three groups had children from various grades, schools, and socioeconomic status.

Group A – This group of 17 children was given syrup Ayurvedic compound I

Group B – This group of 14 children were given syrup Ayurvedic compound I + Shirodhara

Group C – This group of 12 children were given placebo syrup Ayurvedic compound II (placebo)

Drug

For this study, we formulated a compound containing three herbs in appropriate quantity [Table 1]. These three drugs were selected because they are known to have the capacity to interrupt the pathogenesis, arrest the progression, and give symptomatic relief in childhood ADHD, which is a Vata-dominant Tridosaja disease of Manovaha Shrotas. We assumed that drugs that possess properties like VataKaphahar, Deepan, Pachan, Rasayana, and Srothosodhaka, and also are not too Ushna or Katu and Tikshana, may prove effective for getting the desired results.

Method of preparing Ayurvedic compound I and Ayurvedic compound II (placebo)

Ayurvedic compound I: Coarse powder (Yavakut) of the drugs was mixed with sixteen times of water and allowed to soak overnight. After this it is boiled on an electric heater till it was reduced 1/8th of its original volume. Sugar was added to the decoction and the mixture was boiled for 30 min, after which it was allowed to cool. After cooling, coloring and flavoring agents and a preservative were added.

Ayurvedic compound II (placebo): This too was a sugary syrup with the same color and flavor as Ayurvedic compound I, but without any added drug.

Both Ayurvedic compound I and II were processed in the pharmacy of National Institute of Ayurveda, Jaipur, Rajasthan, India. The syrup form was intended to increase palatability.

Dose of drug and duration of treatment

The formulated Ayurvedic compound was given in dose of 1.0 ml/kg/day (using Young’s formula for calculating drug doses) in three divided doses. The children were asked to come for follow-up examination every 15 days for 3 months. Any discomfort or untoward side effects were also documented.

Shirodhara

Shirodhara is a method whereby cow’s milk is poured over the forehead of the patient in the form of a regular stream from a height of precisely 3.14 inches (as mentioned in Dharakalpa of Sahasrayogam) and with a fixed oscillatory movement. The treatment is for 45 min/day over 2 weeks.

Reaction time evaluation by Vernier chronoscope (electronic)

The Vernier chronoscope was used to measure the reaction time of the subject in response to visual or auditory stimuli. The instrument is provided with a start button, upon pressing which the stimulus is presented, and there is a meter for reading the reaction time. The instrument offers three different light stimuli: yellow, green, and red; on presentation of the stimulus, the subject responds by pressing the corresponding key. Two types of sounds (fine and coarse) are provided as auditory stimuli, with their respective keys. For recording the visual reaction time, the yellow, green, and red lights were presented one at a time to the subject, who was asked to press the respective key in response to the stimulus; the time taken to respond was recorded. At least 10 trials were done for each subject and the mean was calculated. The reaction times before and after treatment were compared to assess the efficacy of the treatment.

Observation and Results

A total of 55 patients were included for the study; 12 patients discontinued treatment. Thus, the study conducted on 43 patients. Of the children, 37.20% were in the age-group of 8–10 years, 23.26% in the age-group of 12–14 years, and 20.93% in the age-group of 6–8 years. The majority of the children (72.09%) were males; the male: female ratio was 2.58:1. Among the children, 23.26% were studying in the 1st standard and 18.60% in the 3rd standard. A large proportion (34.88%) of patients had poor academic performance, 20.93% had very poor academic performance, 13.96% had good academic performance, and 9.30% had excellent academic performance.

| Drug name       | Botanical name                  | Part used | Proportion (%) |
|-----------------|--------------------------------|-----------|----------------|
| Brahmi          | Bacopa monnierii Linn           | All parts | 42.86          |
| Ashwagandha     | Withania somnifera Linn         | Roots     | 28.57          |
| Tagar           | Valerian wallichii DC.          | Roots     | 28.57          |

Table 1: Ingredients of Ayurvedic compound I
Discussion

The ADHD-affected children included in the study were in the age range of 6–16 years, which is in accordance with DSM-IV and ICD-10 criteria. The largest proportion (37.20%) was in the age-group of 8–10 years, followed by 23.26% in the age-group of 12–14 years, and 20.93% in the age-group of 6–8 years. This data suggests that ADHD starts in early primary school children\(^{[9,10]}\) with gradual reduction in severity of symptoms as age advances. However, there is only minor attenuation of the symptoms during the whole childhood.

The majority of subjects (72.09%) were males. In all the groups there was a male predominance, with the male: female ratio ranging from 5:1 to 1.5:1. The overall male: female ratio was 2.5:1. This finding is consistent with the previous studies in India as well Western countries, all of which show a male predominance in ADHD.\(^{[11,12]}\)

Maximum numbers (34.88%) of patients had poor academic performance, followed by 20.93% with very poor academic performance, 13.96% with good performance, and 9.30% with excellent academic performance. It appears that students with learning disabilities and ADHD often have dysfunction in many areas of adaptive functioning, including self-esteem, school performance, and family relations.\(^{[13]}\)

Groups A and B showed statistically highly significant changes in visual reaction time (P<.001), while group C show nonsignificant changes (P>.10). On intergroup comparison, groups A and B showed reduction in visual reaction time that was significantly better than that achieved by group C (P<.01 and P<.001, respectively); however, the difference between group B and group A was nonsignificant (Tables 2 and 3).

Highly significant result were seen in group A and B in auditory reaction time (P<.001) while group C show insignificant changes. [Table 4] Table 5 showed statistically more significant gain in group B and A over group C (P<.01, >0.05 respectively) justify effectiveness of Shiroidhara with drug or drug alone on placebo. While group B showed not worth mentioning change over group A (P>.10) on intergroup comparison. [Table 5]

Groups A and B showed statistically highly significant change in Reaction Time (P<.001). Results of group C were statistically insignificant (P>.10). Statistically significant advantage was observed in-group B over group A (P<.001), showing the synergistic effect of drug and Shiroidhara. Groups B had statistically more significant advantage over group C (P<.01) indicating the efficacy of drug with Shiroidhara over placebo while no advantage of group A over group C (P>.10) was observed on intergroup comparison. [Tables 6 and 7]

Result of group B showed statistically highly significant with maximum gain percentage (52.53%) in total reaction time of ADHD as compared to group A (33.29%) and C while group C showed negligible percentage gain(12.13%)[Figure 1].

**Probable mode of action of drug**

On examination of the pharmacodynamic properties of the herbal drugs used in the formulation of Ayurvedic compound I shows that most of drugs have mainly Tikta, Kashaya, Katu, and Madhur Rasa, Laghu, Snigdha and Sara Guna, Katu and Madhur Vipaka, Ushna Vritya, Kapha-Vata Shamaka properties, Medhya and Rasayana Prabhava.

**Figure 1:** Total effect of therapy on reaction time

*Rasa:* Analysis of Rasa present in the individual drugs reveals that the maximum number of drugs have Tikta and Kashaya Rasa. Tikta Rasa, being predominant in Akasha Mahabhuta and Laghu Guna, increases the Sattva part of Mana. Kashaya Rasa has predominance of Vayu Mahabhuta and Laghu Guna, which also increases the Satavika property of Mana.\(^{[14]}\) Vachana Nigrahanati of Kashaya Rasa helps to decrease talkativeness. Katu Rasa dominates in Agni Mahabhuta (Paka Karma) and Ruksha Guna, which are responsible for Indriyautejataka and Sanjjananas. Madhur Rasa being predominant in Parthiva Mahabhuta (Sthairakara Karma).\(^{[15]}\) Snigdha, and Guru Guna, increases the Medhya effect and Indriyasapradhana. Brimhana (by improving cellular nourishment) and Sarvadhatuwardhaka helps in proper development of all tissues in the body.

**Guna:** Laghu and Sara Guna are maximum in proportion. Laghu Guna, by virtue of having properties identical to that of Sattva Guna, increases the Sattva part of Mana that enhances the individual’s Utsaha and Sphurti (stimulate pre & postsynaptic receptors). By the Prerana (channelizing or motivation) property of Sara Guna, Prerana Karma of Vata becomes normalized and attention span is improved. Snigdha Guna increases the qualities of Tarpaka Kaptha and thereby nourishes the Mana and Indriyas. Brain tissue is exceptionally rich in lipid, especially in complex essential fatty lipids; Snigdha Guna is similar to these lipids and thus it can be assumed that these drugs, due to their Snigdha Guna, nourish the brain.

**Vipaka:** Vipaka of all ingredients present in the trial drug compound were Katu and Madhur Vipaka. The metabolism of our body, including the brain, is accelerated by Katu Vipaka, which helps in absorption of micro- as well macronutrients as per the body’s needs and thus brings about a reduction of nutrient deficiencies. While on other hand Madhur is described as Sarvadhatuwardhaka including the brain tissue, Sadindriyaprasadaka (nourish the Mana and Indriyas), alleviate the vitiated Pitta and Vata Doshas, jeevanyaa (increase the vital strength).\(^{[16]}\) It ensures that the brain receives complete nourishment and thus helps in increasing the attention span of ADHD-affected children.

**Virya:** Ingredients used in the preparation of trial drug compound were chiefly of Ushna Virya. Ushna Virya also improves blood circulation in the brain. In 1989, Lou\(^{[15]}\) reported abnormal regional blood perfusions in the straital region of ADHD-affected children. Thus it seems that ADHD-affected children have improper perfusion as well as glucose
metabolism in the brain, which should be improved by virtue of Ushna Virya of the trial drug.

**Doshaghnata**: All the drug ingredients have the property of Kapha Vata Shamaka. In ADHD, vitiation occurs in Vata Dosha that simultaneously vitiates Pitta and ameliorates Kapha. The Kapha Vata Shamaka effect of drugs may help in breaking the Srotorodha and digestion of Ama that leads to the proper functioning of systems of the body and brain. Kapha Shamaka drugs have properties that are opposite to that of Tama Dosha, which may help in dispelling the Avarana and normalizing Tama Dohsa, thereby maintaining the equilibrium of Triguna and the proper functioning of Mana, Chitta and Buddhi. The Tridosha Shamaka effect of drugs brings about homeostasis in Tridosha and Triguna as Vata and Mana interrelated with each other because Vata is responsible for vitiation of Sharirika as well Manasika Dosha and produce disease. Thus, these drugs regularize the functioning of Mana, Sharira, and Manasika Dosha, Dhi, Dhriti, and Smriti that are primitive seat of pathology in the treatment of ADHD.

A variety of Ayurvedic drugs act on the mental level. The selection

| Table 2: Change in visual reaction time (VRT) |
|---------------------------------------------|
| **Groups** | **n** | **Mean score** | **BT** | **AT** | **Diff.** | **%** | **SD** | **SE** | **t** | **P value** |
| Group A | 17 | 1.22 | 0.87 | 0.35 | 28.60 | 0.2569 | 0.0623 | 0.56192 | <.001 |
| Group B | 14 | 1.64 | 0.77 | 0.87 | 52.95 | 0.5567 | 0.1487 | 0.58423 | <.001 |
| Group C | 12 | 1.42 | 1.23 | 0.19 | 13.48 | 0.6312 | 0.1822 | 1.0518 | > 0.10 |

| Table 3: Statistical analysis of intergroup differences in change in scores of VRT |
|---------------------------------------------|
| **Groups** | **n** | **SD** | **SE** | **t** | **P value** |
| A and B | 31 | 0.3963 | 0.1430 | 0.02866 | >.10 |
| A and C | 29 | 0.5780 | 0.2273 | 0.5567 | <.01 |
| B and C | 26 | 0.44314 | 0.1670 | 0.0844 | <.001 |

| Table 4: Showing change in auditory reaction time (ART) |
|---------------------------------------------|
| **Groups** | **n** | **Mean score** | **BT** | **AT** | **Diff.** | **%** | **SD** | **SE** | **t** | **P value** |
| Group A | 17 | 1.46 | 0.90 | 0.55 | 38.13 | 0.4574 | 0.1109 | 0.5049 | <.001 |
| Group B | 14 | 1.63 | 0.80 | 0.83 | 51.12 | 0.5558 | 0.1485 | 0.5632 | <.001 |
| Group C | 12 | 1.40 | 1.26 | 0.14 | 10.47 | 0.6553 | 0.1891 | 0.7797 | > 0.10 |

| Table 5: Statistical analysis of intergroup differences in change in scores of ART |
|---------------------------------------------|
| **Groups** | **n** | **SD** | **SE** | **t** | **P value** |
| A and B | 31 | 0.5041 | 0.1819 | -0.15393 | >.10 |
| A and C | 29 | 0.5496 | 0.2072 | 0.19786 | >.05 |
| B and C | 26 | 0.60614 | 0.2383 | 0.28955 | <.01 |

| Table 6: Showing change in total reaction time |
|---------------------------------------------|
| **Groups** | **n** | **Mean score** | **BT** | **AT** | **Diff.** | **%** | **SD** | **SE** | **t** | **P value** |
| Group A | 17 | 1.33 | 0.88 | 0.44 | 33.29 | 0.2985 | 0.0724 | 0.6126 | <.001 |
| Group B | 14 | 1.63 | 0.77 | 0.86 | 52.53 | 0.4996 | 0.1335 | 0.4295 | <.001 |
| Group C | 12 | 1.43 | 1.23 | 0.19 | 12.13 | 0.6556 | 0.1892 | 0.1892 | > 0.10 |

| Table 7: Statistical analysis of intergroup differences in change in scores of total reaction time |
|---------------------------------------------|
| **Groups** | **n** | **SD** | **SE** | **t** | **P value** |
| A and B | 31 | 0.1532 | 0.0552 | -0.74275 | <.001 |
| A and C | 29 | 0.4720 | 0.1779 | 0.13486 | >.10 |
| B and C | 26 | 0.5507 | 0.2166 | 0.03031 | <.01 |
Conclusion

On the basis of the results of this study, it can be concluded that the drug alone or the drug + Shirodhara were both effective in reducing reaction time in ADHD and thus improve the attention span. The drug + Shirodhara was more effective in reducing reaction time than either the drug or placebo alone.

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हिंदी सारांश

मनोविपर्यय प्रभावित बच्चों में प्रतिक्रिया समयविधि सुधार

पर आयुर्वेदीय चिकित्सात्मक अध्ययन

हरीशकुमार सिंधल नीतू अभिमन्यु कुमार भोती राय

मनोविपर्यय (एडीएचडी) बालव्यवस्था में होने वाला एक मानसिक और व्यवहारिक व्याधि है। जिसको ध्याम में रखें हुये मनोविपर्यय से प्रभावित बच्चों (४३) में मनोयोग अवधि में सुधार के उदेश्य से वनिया क्रोनोस्कोप परीक्षा के द्वारा प्रतिक्रिया समय के आधार पर वर्धित अनुसंधान किया गया। अनुसंख्यानमें चरित्रित बच्चों (दोनों लिंग) को दो सीमा ६-१६ वर्ग को तीन वर्गों में विभाजित कर ३ माह तक चिकित्सा दी गई। वर्ग ए १६ रोगी को सीप आयुर्विदिक कम्प्यूटर ६, वर्ग बी २४ रोगी को सीप आयुर्विदिक कम्प्यूटर ४ + गोदू रे शिरोधारा तथा वर्ग सी ४२ रोगी को सीप आयुर्विदिक कम्प्यूटर २ दिया गया। परिणाम कभी तभी वर्गों में से ही वर्ग की प्रतिक्रिया समय सुधारता में सर्वाधिक सार्थकता पायी गयी जबकि वर्ग सी अर्थमीटर रहा है। जिसके आधार पर यह कहा जा सकता है कि ओषध और शिरोधारा दोनों ही मनोविपर्यय प्रभावित बच्चों की मनोयोग अवधि को बढाने में सहायक हैं परंतु केवल ओषध की तुलना में ओषध + शिरोधारा के परिणाम अधिक भावनाकारी देखे गये।