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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.

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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.

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 posses 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*)[8] 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 stimuli; 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.

Table 1: Ingredients of *Ayurvedic* compound I

Drug name	Botanical name	Part used	Proportion (%)
Brahmi	*Bacopa monnineri* Linn	All parts	42.86
Ashwagandha	*Withania somnifra* Linn	Roots	28.57
Tagar	*Valerian wallichii* DC.	Roots	28.57

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 1.83:1. The overall male: female ratio was 2.58:1. This finding is consistent with the previous studies in India as well Western countries, all of which show a male predominance in ADHD.[1,2,11,12]

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 the change in group C was nonsignificant ($P<.10$). 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 nonsigificant [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 *Shirodhara* 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 *Shirodhara*. Groups B had statistically more significant advantage over group C ($P<.01$) indicating the efficacy of drug with *Shirodhara* 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 pharmacodyanamic 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* Virya, *Kapha-Vata Shamaka* properties, *Medhya* and *Rasayana Prabhava*.

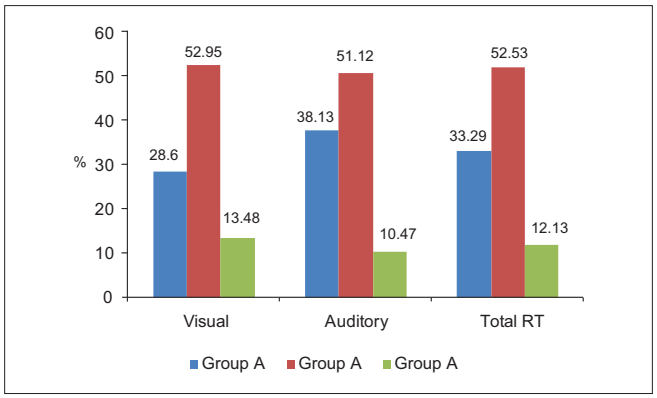

Figure 1:Total effect of therapy on reaction time

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 *Indriyautejetaka* and *Sanjnanasa*. *Madhur Rasa* being predominant in *Parthiva Mahabhuta* (*Sthairakara Karma*),[14] *Snigdha*, and *Guru Guna*, increases the *Medhya* effect and *Indriyaprasadana*. *Brimhana* (by improving cellular nourishment) and *Sarvadhatuvardhaka* 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 the *Tarpaka Kapha* 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 *Sarvadhatuvardhaka* including the brain tissue, *SadindriyapRasadaka* (nourish the *Mana* and *Indriyas*), alleviate the vitiated *Pitta* and *Vata Doshas*, *Jeevaniya* (increase the vital strength).[14] 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

Table 2: Change in visual reaction time (VRT)

Groups	n	Mean score			%	SD	SE	*t*	*P* value
		BT	AT	Diff.					
Group A	17	1.22	0.87	0.35	28.60	0.2569	0.0623	05.6192	<.001
Group B	14	1.64	0.77	0.87	52.95	0.5567	0.1487	05.8423	<.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	02.9828	<.01
B and C	26	0.44314	0.1670	04.0844	<.001

Table 4: Showing change in auditory reaction time (ART)

Groups	n	Mean score			%	SD	SE	*t*	*P* value
		BT	AT	Diff.					
Group A	17	1.46	0.90	0.55	38.13	0.4574	0.1109	05.0409	<.001
Group B	14	1.63	0.80	0.83	51.12	0.5558	0.1485	05.5632	<.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	-01.5393	>.10
A and C	29	0.5496	0.2072	01.9786	>.05
B and C	26	0.6061	0.2383	02.8955	<.01

Table 6: Showing change in total reaction time

Groups	n	Mean score			%	SD	SE	*t*	*P* value
		BT	AT	Diff.					
Group A	17	1.33	0.88	0.44	33.29	0.2985	0.0724	06.1264	<.001
Group B	14	1.63	0.77	0.86	52.53	0.4996	0.1335	06.4295	<.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	–07.4275	<.001
A and C	29	0.4720	0.1779	01.3486	> .10
B and C	26	0.5507	0.2166	03.0031	<.01

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 Dosa*, 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 *Tridosa* 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

of drugs for the formulation of study drug *Ayurvedic* compound I was based on such considerations. These drugs are known to minimize catecholaminergic (i.e., dopaminergic and noradrenergic) transmitter functions and to have an antidepressant effect. Various clinical and experimental trials of *Brahmi* (*Bacopa Monnieri* Linn.) have established its beneficial effect on cognition,[16] its memory-enhancing effect,[17] and its effect on ADHD.[18] *Ashwagandha* (*Withania Somnifra* Linn.) has a nootropic-like effect[19] and also has anxiolytic and antidepressant activity.[20] The third drug used in *Ayurvedic* compound I was *Tagar* (*Valerian wallichii* DC.) and it is known to have a beneficial effect on performance and alertness[21] as well as on GABA receptors.[22]

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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हिन्दी सारांश

मनोविपर्यय प्रभावित बच्चों में प्रतिक्रिया समयावधि सुधार पर आयुर्वेदीय चिकित्सात्मक अध्ययन

हरीशकुमार सिंघल नीतू अभिमन्यु कुमार मोती राय

मनोविपर्यय (एडीएचडी) बाल्यावस्था में होने वाली एक मानसिक और व्यवहारिक व्याधि है। जिसको ध्यान में रखते हुये मनोविपर्यय से प्रभावित बच्चों (४३) में मनोयोग अवधि में सुधार के उद्देश्य से वर्नियर क्रोनोस्कोप परीक्षा के द्वारा प्राप्त प्रतिक्रिया समय के आधार पर वर्तमान अनुसंधान किया गया। अनुसंधानार्थ चयनित बच्चों(दोनों लिंग) वय सीमा ६–१६ वर्ष को तीन वर्गो में विभाजित कर ३ माह तक चिकित्सा दी गयी। वर्ग ए १७ रोगीयों को सीरप आयुर्वेदिक कम्पाउंड १, वर्ग बी १४ रोगियों को सीरप आयुर्वेदिक कम्पाउंड १ + गोदुग्ध शिरोधारा तथा वर्ग सी १२ रोगियों को सीरप आयुर्वेदिक कम्पाउंड २ दिया गया। परिणामस्वरुप सभी वर्गो में से बी वर्ग की प्रतिक्रिया समय सुधारता में सर्वाधिक सार्थकता पायी गयी जबकि वर्ग सी अर्थहीन रहा है। जिसके आधार पर यह कहा जा सकता है कि औषध और शिरोधारा दोनों ही मनोविर्पयय प्रभावित बच्चों की मनोयोग अवधि को बढ़ाने में सहायक हैं परन्तु केवल औषध की तुलना में औषध +शिरोधारा के परिणाम अधिक प्रभावकारी देखे गये।