CASE STUDY

EFFECTS OF VESTIBULAR STIMULATION ON ATTENTION AND HYPERACTIVITY IN A CHILD WITH ADHD: CASE STUDY

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ABSTRACT

Background: The study documents the results of vestibular stimulation intervention on attention and impulsive behaviour of a child with Attention Deficit Hyperactive Disorder (ADHD).

Case Presentation: A 9-year-old male presented with cardinal signs of inattention and hyperactivity as excessive fidgeting, poor communication and language skills and completely dependent.

Results: ADHD Rating Scale and WeeFIM showed significant improvement in attention span and hyperactivity which led to improved function.

Discussion: Cerebellum acts as an integral node in pathways that serve sensorimotor, cognitive, autonomic and affective processing. Its connections with limbic structures and prefrontal cortex are important for normal attention and cognition.

Conclusion: The findings are consistent with the current body of literature that establishes the role of cerebellar connections with other regions for normal attention and cognition.

Keywords: ADHD, Vestibular stimulation, Cerebellum, ADHD

INTRODUCTION

ADHD is a neuropsychiatric, behavioural disorder featuring inappropriate hyperactivity, impulsiveness and inattention, often generalised as excessive daydreaming with a global prevalence of 3-8%.[(1)] According to the Diagnostic and Statistical Manual of Mental Disorders, 5th Edition (DSM - 5) of American Psychiatric Association, 2013, symptoms must be present for 6 months or more and appear by 12 years of age and cause significant problems in functioning in at least 2 settings (social, school/work, home) to receive the diagnosis.

Vestibular stimulation involves motor stimulation of the semi-circular canals and otolith structures (utricles and saccules) of the inner ear, with therapy/Swiss balls, cushions, trampoline, swings and merry-go-round swings/carousels. [(2)]

Imaging, brain morphometry and volumetric studies reveal smaller cerebellum, prefrontal cortex and striatum in children with ADHD. [(3)]Cingulo-fronto-parietal(CFP) activation along with striatum, premotor area, thalamus, basal ganglia and cerebellum have been identified as nodes within parallel networks of attention, cognition and executive function. Their disruption is relevant for the behavioural features of ADHD indicating that a single abnormality of a single region does not cause ADHD. [(4)]

Most of the literature on physical therapy for children with ADHD focuses on achievement of motor coordination and balance with exercise therapy, with limited studies using vestibular stimulation with balance training. [(5,6)] The paucity of studies using vestibular stimulation for behavioural, emotional and cognitive modulation in children with ADHD led to the selection of the particular intervention for this study.

MATERIALS AND METHODS

Client characteristics: The patient was a 9-year-old male child from a middle class family. As per his mother, the pregnancy was well-planned with no perinatal adverse events, delivery was full-term with prolonged duration of labour of 48 hours. As he grew, parents noted a delay in the achievement of head control until the age of 8 months when he had a seizure. After the event, he started not responding to speech and appeared uninterested to the surroundings unlike children of his age. There were occasional episodes of seizures, 2 times a month with delay in crawling and sitting which were achieved only after 12 months of age.

Anticonvulsants (Encorate Syrup, Lacorate) and antipsychotic (Sizodon) were prescribed as required for controlling the seizures. At the age of 5, he was diagnosed with ADHD by a child psychologist based on psychoeducational assessment. The parents enrolled him to a day-care centre where he received visual stimulation with colourful objects, auditory stimulation as music therapy, play therapy and group exercise sessions by a physical therapist and routine care from social workers.

Examination Findings: On observation, he had excessive fidgeting of hands at rest, difficulty sustaining attention and running about excessively, unable to cross barriers. He had blank facial expressions, not oriented to time and place, but only to known persons i.e. his mother and day-care educator. He scored E4V1M6 on Paediatric GCS with minimal speech capabilities, which consisted of mainly monosyllables. Behavioral assessment rendered him inattentive, distracted and impulsive. ADHD Rating Scale documented a score of 24 for inattention and 12 for hypersensitivity and impulsivity with a final score of 36/56 revealing a significant impairment in attention span.

On examination, no physical asymmetries or deformities were documented. Sensory and cranial nerve examination were normal. He responded well to auditory stimuli as an inclined focus to such objects. Motor examination revealed normal tone, strength, ROM and deep tendon reflexes. Surprisingly, grasp and Moro reflexes were present. Balance examination was performed over a high chair and repeated over a Swiss ball. Static balance was inferred well as he was able to stay

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upright after application of perturbations. For dynamic balance, he was made to reach out to auditory toys and the response was satisfactory. He could not walk in a straight line and would stagger on reaching any barrier such as door threshold or a stair. Functionally, he was completely dependent on his mother for ADLs at home and caretakers at the day-care with a FIM score of 48/126.

Clinical Hypothesis

Based on the findings, he exhibited poor social interaction, communication and language skills and social behaviour. These findings of attention dysfunction, distractibility and impulsivity can be the result of myriad dysfunctional processes contributing to ADHD as a whole. Abnormalities of cerebellum and other parallel connections underlying anticipation or planning of actions, response selection or inhibition, target selection, error signalling, reward evaluation and feedback mediated decision-making processes could present as ADHD symptoms. [4] Basal ganglia and cerebellum are not only responsible for motor control but also cognitive and emotional functions. Moreover, connections of cerebellum with limbic structures and prefrontal cortex are important for normal attention and cognition. [7]

The semi-circular canals sense angular whereas the otolith organs sense linear acceleration, projecting to more superior and more inferior vestibular nuclear regions respectively while also projecting directly to most cerebellar regions. Thus, vestibular stimulations can be hypothesised to have an inhibitory effect on brain regions controlling attentional or cognitive responses while acting through the central node of the circuitry i.e. the cerebellum responsible for modulation of balance and fine motor coordination.

Intervention

The vestibular stimulation program is outlined below:

For semi-circular canal stimulation;

1) Rotation in a merry-go-round: Clockwise and Anti-clockwise;
2) Rolling while the child in side lying: Forward and Backward

For otolith stimulation;

1) Sitting on a Swiss ball,
2) Lying prone on a Swiss ball,
3) Jumping on a trampoline while rotating 360°.

The intervention was provided 4 times per week on alternate days and Sundays for 1 hour/day for 2 months. Other interventions at the day-care were continued as before.

RESULTS

He completed the intervention regularly with proper guidance, supervision and safety. At the end of 2 months, symptoms were assessed again using the ADHD Rating Scale whereas the level of functioning was recorded using the WeeFIM. Results were compared in terms of duration of attention span and the frequency of fidgeting. On the ADHD Rating Scale, he scored 18 for inattention and 6 for hyperactivity and impulsivity; a total score of 24/56. Although only small increment in WeeFIM scores was noted with a total score of 55/126, it is significant, given his level of attention span.

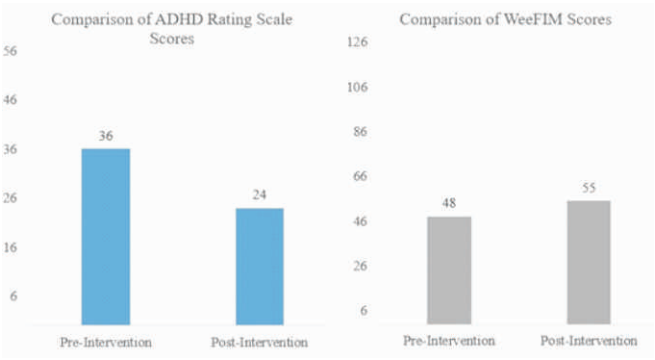

Figure : Pre- and post-intervention scores on ADHD Rating Scale and WeeFIM.

Changes were evident at the day-care as responding on being called by name, improved orientation to the surroundings and other children. With improved participation, he was able to follow the ball during play but still required assistance during catching, throwing and kicking activities. Additionally, there was a considerable reduction in fidgeting of hands at rest. He started addressing the near objects and other sources of stimuli evident with reduced daydreaming and wandering.

DISCUSSION

This case report describes the effect of vestibular stimulation on attention, hyperactivity and function in a child with ADHD. This was the first time he was administered vestibular stimulation intervention and results were encouraging. The findings of improved level of attention are consistent with the hypothesis. It is worth mentioning that changes in attention and emotional modulation were observed during intervention sessions as he smiled and laughed with joy especially when kept on a merry-go-round and when made to sit and jump over the Swiss ball. The fidgeting of hands at rest reduced drastically as he could focus on other things even at rest. Findings of improved attention due to the improved level of consciousness have been supported by many studies. (8,9) The impact of the regular and steady rhythm of vestibular stimulation on hyperactivity is observed as gradual calming effects due to uniformity in the autonomic nervous system. (10) Vestibular connections with cerebral and subcortical structures and networks of multiple parallel loops and re-entering circuits engaging motor, associative and limbic territories are responsible in the control of movement, behaviour and emotions with such precision ensuring effective and harmonious final output.

CONCLUSION

This study describes the use of vestibular stimulation in modulation of inattentiveness and hyperactivity in a child with ADHD. Interaction of various neural networks with the cerebellum and direct connection of vestibular system to the cerebellum implicate the use of vestibular stimulation in conditions with cognitive and behavioural disorders. Vestibular stimulation can be easily performed at clinical and community setup with proper guidance. Further studies are warranted in this area to develop evidence-based treatment applications.

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