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Utilizing Bal-A-Vis-X Exercises as an Adjunct to Physical Therapy Treatment of a Child with Autism and ADHD: A Case Report and Literature Review

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Abstract

Background: Autism is one of five diagnoses classified within autism spectrum disorder. The diagnosis is characterized by communication and sensory impairments, repetitive behaviors, and gross motor delays. While physical therapy is not a primary treatment for these children, physical therapy intervention addressing motor dysfunction may facilitate improved social interaction with peers. **Purpose:** The purpose of this case study is to address the use of Bal-A-Vis-X exercises that incorporate a multisystem approach in conjunction with pediatric physical therapy treatments for a child with a gross motor delay and previous diagnoses of autism and attention-deficit hyperactivity disorder (ADHD). **Case Description:** A 6 year-old boy, diagnosed with autism and ADHD, participated in physical therapy at a pediatric outpatient clinic to address his gross motor delay, balance deficits, gait abnormality and coordination impairments over several years. **Intervention:** Over a course of three years, several different multisystem exercises from the Bal-A-Vis-X program were incorporated into this child's plan of care as an adjunct to primary interventions. **Outcome Measures:** The Bruininks-Oseretsky Test of Motor Development and Proficiency, Second Edition (BOT-2), which assessed coordination, balance and strength, was assessed every six months. The most recent six-month interval did not show notable improvements within two subscales: body coordination and strength and agility motor area composites. However, the Canadian Occupational Performance Measure (COPM) may be used to identify patient or parent reported changes in performing challenging activities. **Discussion:** Although improvements were not seen with BOT-2 testing, parent and self-report measures, such as the COPM, may best measure therapeutic benefits of Bal-A-Vis-X exercises. Further research addressing physical therapy management and assessment of children with autism is needed to improve functional outcomes.

Keywords: Autism; attention deficit and hyperactivity disorder; ADHD; spectrum disorder; pediatrics; Bal-A-Vis-X; physical therapy; rehabilitation

Background

Autism is one of five major diagnoses that have been classified underneath the umbrella term "autism spectrum disorder (ASD)." [4,8] Autism has been categorized as a developmental disability significantly affecting verbal and non-verbal communication and social interaction, generally evident before 3 years of age that adversely affects a child's educational performance.[4] The prevalence of children who are diagnosed with autism spectrum disorder has increased within the past decade, and it is estimated now that 1 out of every 68 children born is diagnosed with ASD.[8]

Attention deficit hyperactivity disorder (ADHD) is another common diagnosis that is seen within the pediatric population. ADHD is characterized by inattention, impulsivity and hyperactivity, and children may have one, two or even all three behaviors, that interfere with typical development or functioning.[2] The Center for Disease Control (CDC) estimates that in 2016, the amount of children that were ever diagnosed with ADHD was 6.1 million.[2] The CDC estimates close to 14% of these children diagnosed with ADHD, have also been diagnosed with autism.[2]

Children with autism present with varying difficulties of sensory processing, communication, and often demonstrate stereotyped/repetitive behaviors.[4] Due to the nature of this diagnosis and the children's needs, it is more common for those with autism to receive occupational and speech therapy, and less common to receive physical therapy. However, in recent years there has been a greater awareness among healthcare professionals and parents that children with autism can also exhibit motor delays, and so utilization of physical therapy services has improved. When motor delays are present in children with autism, common deficits are: hypotonia (low muscle tone), gross motor delay, gait problems, toe walking and apraxia.[4] Each of these deficits can be addressed with skilled physical therapy intervention in order to facilitate the development of age-appropriate gross motor skills. Even if gross motor delays are not the most prominent feature of this diagnosis, improving this aspect may facilitate improvement within areas such as social engagement and the academic realm.[6] Thus, in children with motor symptoms, it is imperative that physical therapy be included in the multi-disciplinary care that these children receive.

Pediatric physical therapy management of children with these diagnoses strongly emphasizes family centered care.[4] A strong bond is established between the physical therapist, the child and their family during the initial evaluation that continues to evolve in efforts to provide the most effective care. There are some studies regarding physical therapy management of children with autism and ADHD, but their sample size, design and methodology all have limitations.

While there are a number of approaches used in pediatric physical therapy, one multi-system program that incorporates balance, auditory and visual systems with 300 different exercises to assist with the development of gross motor skills, is called the Bal-A-Vis-X program.[1] A balance board, racquetball, sand-filled bags and a partner are the only tools needed in order to complete each exercise. Each exercise can be adjusted and progressed depending on the age and ability of the child.[1] These exercises have been used in a wide range of environments; by occupational therapists and teachers in school settings, as a means to improve balance, coordination, ball-handling skills, sustained attention to task, practice with crossing midline and to address motor planning deficits.[1] As many may not be widely familiar with Bal-A-Vis-X, the remainder of this case report will focus on this aspect of a child's plan of care.

Thus, the purpose of this case study is to highlight the utilization of exercises that incorporate a multisystem approach in conjunction with pediatric physical therapy treatments for a child with a gross motor delay and previous diagnosis of autism and ADHD. While the patient participated in physical therapy over several years, the most recent six-month interval was highlighted.

Case Description

History

The patient was a 6-year-old male that had been receiving physical therapy at a pediatric outpatient facility due to developmental motor delays since the age of three. His parents and

pediatrician first recognized his deficits. The child was diagnosed with attention deficit hyperactivity disorder-combined type (ADHD) and was diagnosed with autism shortly after beginning physical therapy. The child also received other therapies; including school-based occupational and speech therapy and enrichment social skills offered by a local hospital.

His parents reported that the child was born full term (42 weeks) via cesarean section. Pregnancy complications included gestational diabetes. Complications with birth and delivery included low birth weight and a short neonatal intensive care unit (NICU) stay. Per the mother and father, the child stayed several days in the NICU so that physicians could monitor and improve his oxygen saturation and hypertension.

His father reported that his child achieved his gross motor milestones (rolling, sitting, crawling, standing and walking) within a normal time frame. However, they began to notice that he was very clumsy and uncoordinated, most notably with his ball skills and he began toe-walking more often, which warranted their referral for a physical therapy evaluation around the age of three. The parents' goals for physical therapy were for their child to improve his speech and gross motor delays, improve coordination and his ability to safely navigate busy community environments.

Examination and Evaluation

The initial evaluation was completed by a different physical therapist that saw him at the beginning of his care, 3 years ago. At that time, the therapist attempted to complete the Peabody Developmental Motor Scales, second edition (PDMS-2) in order to assess his gross motor abilities, however the therapist as unable to complete the testing due to child's inability to follow specific instructions. Objective findings included bilateral foot pronation, inability to achieve heel-toe gait pattern, primarily ambulating on tiptoes, however he was able to achieve foot-flat positioning with cueing. When assessing ball skills, the physical therapist noted decreased aim, poor throwing mechanics and decreased attention, leading to an inability to catch the ball successfully. Functionally, the therapist found strength deficits with stair navigation, and observed that the child used a step-to pattern instead of reciprocal stepping.

Re-Assessment

In April of 2018, at the age of 6 years, the child completed the Bruininks-Oseretsky Test of Motor Development and Proficiency; Second Edition (BOT-2) for the first time to assess a wide array of motor skills used for individuals aged 4-21.[9] The BOT-2 evaluates gross and fine motor components that consist of 4 motor area composites, 8 subtests, with 53 items that are scored.[9] The BOT-2 has excellent test-retest reliability for children ages 4-7.[9] In this pediatric outpatient clinic, the physical therapists complete the Body Coordination and Strength and Agility motor area composites, which include bilateral coordination, balance, running speed and agility and strength subtests. Within these subtests, there are between 5-9 items the child is tested and subsequently scored on. The raw score for each item corresponded to a point score, which was totaled for each subtest and then converted into a scale and standard score relative to other males his age.[9] Percentile ranks were then given based on the standard score each motor area composite receives. MCID for the Body Coordination motor composite is 1.65 and Strength and Agility motor composite MCID is 1.39.[9] At this particular clinic, the occupational therapists completed the Fine Manual Control and the Manual Coordination motor area composites. The BOT-2 test identified below average scores in several of the categories; see Table 1 for the composites assessed by physical therapy.

Table 1: April 2018 BOT-2 Testing

	Total Point Score	Scale Score	Standard Score	Percentile Rank (%)	Descriptive Category
Body Coordination					
Bilateral Coordination	12	13			Average
Balance	22	9			Below Average
Sum Scale Score		22	40	16	Below Average
Strength and Agility					
Running Speed and Agility	16	10			Below Average
Strength	8	9			Below Average
Sum Scale Score		19	39	14	Below Average
Sum Standard Score			79		

Clinical Impressions

The BOT-2 results indicated this child demonstrated deficits with gross motor skills compared to his age and gender-matched peers. The physical therapist identified that his core strength, balance, motor planning and coordination were areas of weakness. The child's most significant difficulties were within the strength and agility motor composite area. Static balance exercises were not significantly difficult, but more dynamic exercises that required multiple steps were challenging for the child to complete. The patient was not able to complete "V-ups"(in prone, extending both upper and lower extremities comparable to the superman exercise), push-ups, or sit-ups with proper form. Goals of therapy were to address these identified strength deficits with functional and creative activities in order to improve his communication, ability to participate in age-appropriate play and social interaction skills.

Interventions

Three-year Overview

Over the past three years, physical therapy treatments included one to two, forty-five minute sessions per week. A variety of interventions were utilized targeting his gait mechanics, balance, strength and coordination. Since the initiation of physical therapy, the frequency of toe walking had decreased significantly, and the patient was able to correct this with verbal cues. The emphasis of his treatment within the past six-months reflected activity-based milestones, such as jumping rope and bike riding. This was the primary focus since his parent's goals from the beginning of therapy were to improve his coordination and gross motor delays so that he could keep up with his peers. Within the past year, the physical therapist that was working with this child initiated the use of Bal-A-Vis-X exercises. Description and rationale regarding the incorporation of these exercises into this child's weekly physical therapy treatments will be described below.

Intervention Overview

One intervention that was used consistently in the child's therapy was Bal-A-Vis-X exercises. These exercises require a partner to complete, and emphasize the integration of the visual and auditory systems while simultaneously challenging the child's balance. There are hundreds of different patterns that can be modified or progressed.

This intervention was chosen for this patient because many children with autism have deficits with motor planning and coordination. Bal-A-Vis-X emphasizes cross body midline when passing the racquetball or bag from their right hand to their left hand, which many children with coordination deficits

have difficulty executing.[1] Furthermore, the expectation with these Bal-A-Vis-X exercises is to develop a rhythm, which can improve sustained attention to a task. In addition, upon initial physical therapy evaluation, this child presented with balance and ball skill deficits, and so this was an exercise that challenged his balance on an unstable surface.

The most basic Bal-A-Vis-X exercise can be performed in tailor sitting passing sand-filled bags back and forth with your partner in a rectangular pattern, and can progress to standing on a balance board, bouncing and catching a racquetball in a particular pattern.[1] Each exercise can start with one bag/racquetball, and progress to two-bags/racquetball. You can challenge the child by completing the cycle in clockwise or counterclockwise, non-consecutively or consecutively.

9 week Overview of Exercise Utilization

A description of the exercises used over a 9-week period are provided to highlight the utilization and progression of exercises for this patient, focusing on the Bal-A-Vis-X exercises, beginning in May of 2018, one month after the re-assessment.

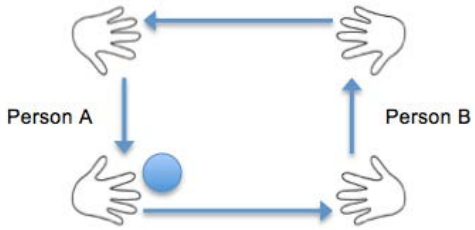

Figure 1: One Ball Example

Weeks 1-2: At this point in his physical therapy care, an emphasis was placed on improving his ability to jump and balance. The child completed stationary hula-hoop jumping, two-foot jumping forward, tandem walking on ground and tandem walking on the balance beam. One of this child's physical therapy goals was to complete the superman exercise, which is an indicator of core strength. The child began quadruped alternating arm raises as the first step to progressing towards completing the superman exercise. He completed the following Bal-A-Vis-X exercises: 1-ball Rectangle (Figure 1), 2-ball rectangle (Figure 2) and 2 ball drop/pass/catch.

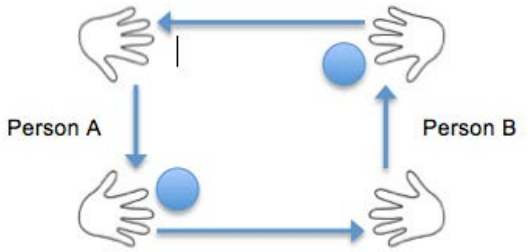

Figure 2: Two-Ball Example

Week 3-5: During this interval, the child improved his ability to complete tandem walking on level ground, however consistency was variable with tandem walking on the balance beam. This was largely dependent on his attention span that day and the amount of children in the gym at the time. He performed the following Bal-A-Vis-X exercises: 1-ball Rectangle, 2-ball rectangle (Figure 2) and 2 ball drop/pass/catch. He was also learning how to ride a 2-wheeled bike and was able to complete several revolutions before requiring external assistance to maintain midline. Stationary hula-hoop jumping was progressed to using an actual jump rope, and the patient was instructed on how to complete the jumps non-consecutively.

Week 6-7: At this point, the patient was jumping rope non-consecutively and so he was instructed to complete jumping consecutively, with therapist guiding the jump rope to increase the fluidity of movement. The patient progressed to higher-level balance beam exercises, reaching for objects and touching cones outside of his base of support. Bal-A-Vis-X exercises progressed to 2-ball rectangle, 2-ball oval, 1 ball drop/catch and 2-ball drop/catch. During these weeks more strengthening exercises were included to increase core and leg stability, and so the child completed squats on the bosu ball, quadruped with alternating leg raises, completed activities on a scooter using his legs to propel and in prone using his arms to propel, activating back extensors, glutes and hamstrings.

Week 8-9: The child was completing Bal-A-Vis-X 1 and 2-ball rectangle, 1 and 2-ball drop/catch and drop/pass/catch. The patient was challenged to complete all of these consecutively without error and was able to complete each of these with 80-90% proficiency. Strengthening exercises such as squats, scooter and quadruped alternating leg raises were progressed to bird-dog exercises with the patient demonstrating improved core stability, and he was able to complete a superman with proper

form for 10 seconds. Jumping exercises were still being incorporated at this time, with single leg hopping being most recently introduced. This was very difficult for the patient to complete; however it appeared this was due to motor planning deficits.

Outcomes

At this specific pediatric outpatient clinic, standardized BOT-2 testing is completed every six months. However, the therapists do take into account the child's diagnosis and their expected progression within physical therapy when determining the timeframe to re-test. Since these children are typically seen for therapy throughout their lifetime, standardized testing is not completed in a shorter timespan, such as in the outpatient orthopedic setting.

The results of the six-month follow-up BOT-2 testing are provided in Table 2. It is important to note that the child improved his total point score for his balance composite, but due to the fact that that the BOT-2 is norm-referenced to age and gender matched peers, he is still considered below average compared to other children with that particular subtest. Furthermore, the second assessment was completed by a different physical therapist, which may have impacted the total point scores given. Regardless, the child scored below average compared to age and gender matched peers in all categories assessed. The area that this child had the most deficits was within the strength and agility motor area composite. While BOT-2 test is standard for many pediatric patients, not all therapeutic benefits believed to result from the Bal-A-Vis-X exercises are assessed with BOT-2 testing. For example, ball-handling skills are not addressed in the BOT-2 subtests that were assessed. One benefit of Bal-A-Vis-X exercises was that they address ball-handling skills, which was a deficit that was noted by the patient's parents. Further testing, considering upper limb coordination, would be beneficial to further assess the potential benefit of Bal-A-Vis-X exercises.

While this child did not demonstrate improvement through standardized testing in this test-retest interval, there may have been benefits in ways that cannot be measured through outcome measures. Throughout the nine-week intervention highlighted here, the child went to day camp with other children. There were several instances when the child was seen with his peers or camp counselors, playing catch and engaging in reciprocal play. Many of these activities were not possible previously.

Table 2: October 2018 BOT-2 Testing

	Total Point Score	Scale Score	Standard Score	Percentile Rank (%)	Descriptive Category
Body Coordination					
Bilateral Coordination	11	10			Below Average
Balance	25	10			Below Average
Sum Scale Score		20	38	12	Below Average
Strength and Agility					
Running Speed and Agility	14	7			Below Average
Strength	6	7			Below Average
Sum Scale Score		14	34	6	Below Average
Sum Standard Score			72		

Discussion

This case report addresses the use of Bal-A-Vis-X exercises in conjunction with multiple treatment interventions over a nine-week period, and so it is difficult to determine whether or not the decline in the child's BOT-2 test scores were a result of the interventions implemented, or an inherent challenge that children with gross motor delays experience. Significant or noticeable gains in physical therapy made by a child with a gross motor delay may not be recognizable to a child or therapist in the timeframe that the outcome measures are taken, as these delays may take years to improve, and even then, the scores may not correlate to the descriptive category "average" that is used in the BOT-2. Even if clinically significant improvements were to be seen for a child from one BOT-2 evaluation to the next, that does not mean that the child will have the gross motor capabilities that other children his age and gender have. This is a challenge that many of these children will experience throughout their lifetimes. Furthermore, the Bal-A-Vis-X intervention was only one of many interventions utilized in this child's plan of care, and so it is difficult to quantify the value of this intervention alone unless it was compared to individuals with the autism diagnosis who receive no treatment.

While improvements were not seen in the outcome measures used in this case report, there are other outcome measures that include self or parent reporting, that could also have been used. There are several parent or self-reported outcome measures used within the pediatric population that could be utilized for this patient such as the Canadian Occupational Performance Measure (COPM), which is a criterion-referenced test that allows the child or parent to assess their performance and satisfaction with certain activities over time.[5] Children ages 8+ are able to self-report, and parents can report for those that are younger. This test is commonly used within occupational therapy, but can be useful for physical therapists as the parent/child are able to identify certain "occupations" or activities that are more challenging for them to complete.[5] Test-retest reliability for the performance section is 0.63, and 0.84 for satisfaction.[5]

Although research is limited regarding the benefits of Bal-A-Vis-X exercises with children, one study wanted to determine if there were non-pharmacological approaches that could be utilized as treatment for children with ADHD, primarily in underserved populations.[3] Eighteen children participated in the study; eleven completed a six-week Bal-A-Vis-X program, four children received ADHD medication and three children received medication and Bal-A-Vis-X training.[3] The study found that the children that utilized Bal-A-Vis-X training and medication demonstrated the greatest improvements in sustained attention, however the children that completed just the Bal-A-Vis-X training increased their attention span by fifteen minutes.[3] It is unclear if this intensive program is something that would be feasible to incorporate into a pediatric outpatient physical therapy clinic, as many of these children have school and other therapies to attend. However, if modifications could be made to this program, it is possible that these children could experience outcomes similar to this study.

It is important to note that the effectiveness of physical therapy interventions is challenged when the child in the case report has a previous diagnosis of both ADHD and autism. A child with autism that may demonstrate difficulty with motor planning will experience further difficulty due to increased distractions. Typically, significant change is not seen in a six-month time period such as this case report, but rather seen over a period of years. A study conducted by Ming et al. (2007) addressed the prevalence of motor impairments with children with autism between the ages of 2-6 years and then 7-18 years old.[7] It was found that 63% of children ages 2-6 had hypotonia whereas prevalence of low tone in 7-18 year olds with autism was only 38%.[7] Further results from the study suggest that these motor deficits improve over time, but they did not differentiate if natural progression or interventional therapy were the cause.[7]

Due to the limited nature of physical therapy intervention within the pediatric autism population, further research needs to be conducted on specific therapeutic treatments. A systematic review assessed the use of hippotherapy, jogging, cycling and weight-training and found that there was a 37% improvement in symptomatology of autism, with a majority of this improvement correlating to academic and behavioral improvement.[11]

There has been emerging evidence associated with aerobic exercise benefits for children with autism, neuromuscular or resistance trainings.[11] Guidelines that have been given to address this suggest 2-3 days a week of short bouts of aerobic training, accumulating up to 20-30 minutes total.[11] Aerobic exercise options include jogging, walk/run interval training, swimming, Wii, Dance Dance Revolution etc.[11] Furthermore, they suggest 1 day of resistance training a week, 1 set, 10-15 reps incorporating jumping, climbing and throwing for younger children, and progressively more intensive exercises incorporating theraband, weight machines and bodyweight resistance for older children with autism.[11] Finally, they suggest one hour of neuromuscular training per week, which could include hippotherapy, aquatic therapy, yoga or Tai chi.[11]

Conclusion

This case report regarding physical therapy management of a six-year old boy with autism and ADHD highlights the utilization of Bal-A-Vis-X exercises as an adjunct treatment within his plan of care. While this may not have correlated to increases in strength, coordination or more dynamic balance activities within the six-month reassessment period, there may be therapeutic benefit with ball skills and improved social interaction with peers that could have been assessed using an alternative outcome measure, such as the COPM. This case study highlights the plan of care regarding management of a child with autism and ADHD. Often in cases with children with gross motor delay, change is not seen within months, but rather years, and is further challenged by the age-related normative expectations for coordination, balance, and strength. Many of these children have a difficult time achieving their developmental milestones at the same rate as the “average” child. There have been studies assessing the beneficial effects of aerobic exercise on behaviors seen within the autism population; however, more evidence regarding which form exercise provides the most therapeutic value is imperative. Longitudinal studies assessing the benefit of physical therapy intervention within this ASD population versus natural progression will be beneficial and will continue to highlight the benefits of skilled physical therapy that addresses the needs of the child and their family.

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