

To Study the Effectiveness of Rotational Vestibular Stimulation on Improving Balance and Gravitational Insecurity in Children with Down Syndrome-A Research Protocol

Gauravi Desale¹, Ketaki Naik², Dipti Shinde¹, Rinkle Malani²

¹Final Year BPT, MGM School of Physiotherapy Aurangabad Maharashtra, ²Professor and Principal, MGM School of Physiotherapy

Abstract

Background: Children with Down Syndrome have delayed motor development and coordination due to which they have poor balance. Balance is the condition in which all the forces acting on body are balanced such that the center of mass (COM) is within the stability limits, the boundaries of base of support (BOS). Several scales are available for assessing balance. However, standardized and reliable scales have been chosen to prevent the error while testing. Many studies have been conducted showing that sensory integration therapy improves balance. However, there is paucity of study on Rotational Vestibular Stimulation in improving balance.

Objectives: To study whether the rotational vestibular stimulation will improve balance and gravitational insecurity in children with down syndrome. To study the differences in pre-treatment and post-treatment parameters after rotational vestibular stimulation using outcome measures.

Methods: Balance will be assessed prior to treatment and after the treatment. The measures used for assessing will be Pediatric Balance Scale, Bruininks-Oseretsky Test, Movement Assessment Battery for Children.

Results: Once the study is completed, the parameters of outcome measures will be statistically analyzed.

Conclusion: Based on previous researches, it may be predicted that there will be significant improvement in balance in children with Down syndrome.

Keywords: Downs syndrome, rotational vestibular stimulation

Introduction

Down syndrome is a genetic disorder of chromosome number 21 present in triplicate, the origin of extra chromosome 21 being either maternal or paternal. ⁽¹⁾ The estimated incidence of down syndrome is between 1 in 1000 to 1 in 1,100 live births worldwide. Each

year approximately 3000 to 5000 children are born with this chromosomal disorder. ⁽²⁾ There are many neuromuscular and musculoskeletal characteristics in Down Syndrome that can result into developmental delays. ⁽³⁾ Children with down syndrome show motor dysfunctions which are poor balance, motor incoordination and hypotonia with oculomotor dysfunction and vestibular deficits. ⁽⁴⁾ A smaller cerebellum and brain stem is seen in down syndrome causing loss of neurons in many parts of brain due to generalized hypocellularity of brain with decreased myelination of brain hemispheres, basal ganglia, cerebellum, brain stem in first year of life. These factors may cause motor and postural delays. ⁽³⁾

Corresponding author :

Dr Pallavi Palaskar

Assistant Professor, MGM school of physiotherapy
Aurangabad Maharashtra
ratnaparkhipallavi@gmail.com
9604487807

The main function of vestibular system is development of motor skills, integration of postural reflexes, coordination of eye movements and visual attention skills. Developmental disorders such as motor incoordination and learning disabilities are observed in vestibular dysfunction. ⁽⁵⁾ Vestibular end organs produce signals on stimulation which are transmitted via eighth cranial nerve to the vestibular nuclei in the brain stem to vestibular portion of cerebellum then to motor cortex which is responsible for coordination of motor responses, head position, posture and eye movements. It was found that rotational vestibular stimulation of children with Down syndrome showed improvement in motor performance of these children. ⁽⁶⁾ Vestibular dysfunction results in abnormal reflex and leads to sensation that responds to abnormal information about motion from vestibular receptors. Acceleration or rotation of head movement results in asymmetric stimulation of neuroreceptors in the labyrinth and produces vestibulo-ocular reflex (VOR), resulting in stimulation of the sensory canal integrating the sensed angular head acceleration with output head velocity information to brain. ⁽⁴⁾

Balance or Stability defined as status of keeping balance between mutual forces. It is also called as "Postural Control". Postural control is the ability to maintain balance in gravity field by staying on or returning to body's center of gravity within the base of support. In children with Down syndrome with balance issues increase their base of support while sitting, standing and walking in order to achieve stability. ⁽⁷⁾ Due to coordination of many brain structures movement control is achieved which was organized both hierarchically and in parallel. In hierarchically, a signal is processed within the ascending levels of central nervous system (CNS). In parallel distributed processing it shows that same signals may be processed simultaneously among many different brain structures. In perception, action and cognitive systems of movement control hierarchical and parallel processing occur in alliance. ⁽⁸⁾ An object when translated or rotated simultaneously a challenge arises leading to how much locally recognized translational motion signal is generated by object and how much

is generated by rotation of object. ⁽⁹⁾

Daryoush Didehdar, Ameneh Kharazinejad, 2019, in their study showed that there is improvement in static and dynamic balances with sensory motor integration activity in children. In this children have participated in their favorite games with their peers. They compared effectiveness of sensory integration treatment and combination of sensory integration therapy with vestibular stimulation and treatment of nerve growth. It was seen that there was significant improvement with subtest pertaining to sensory integration and subtle motor skills in therapy group ⁽⁷⁾.

Annabelle Nommensen, Frikkie Maas, 1993, Their study revealed that vestibular stimulation was unclear. The sensory integration therapy approach studied on children with Down syndrome had been inconsistent and dominated by methodological flaws. The failure to the study was due to inadequate sample size and lack of control for heterogeneity evident in that population, also there was failure to employ standardized measures of gross motor function, fine motor function and vestibular function and they did not apply statistical analysis to outcome results ⁽¹⁰⁾.

Mine Uyanik, Gonca Bumin and Hulya Kayihan, 2003, in their study concluded that there was significant improvement in all three groups. In first group sensory integrative therapy was given, they found there was improvement in sensory integration subtest and fine motor skills. In second group sensory integrative therapy and vestibular stimulation showed improvement in sensory integrative subtest, vestibular system, fine hand skills, reflex development and gravitational insecurities. In third group where NDT showed significant difference in all capabilities ⁽⁵⁾.

Sarah Sunderman, 2016, Concluded that group 1 included 10 participants with Down Syndrome and group 2 consisted of 8 participants with intellectual and developmental disabilities. Tests were done based on Bruininks-Oseretsky test of motor proficiency which was shown to be effective. During this analysis it was observed that there was lack of understanding of

participants about the the equipment's used. Limitation of the study was small sample size and lack of control group and limited participants from the particular program ⁽⁴⁾.

Objectives:

i. To study whether the rotational vestibular stimulation will improve balance and gravitational insecurity in children with down syndrome.

ii. To study the differences in pre-treatment and post-treatment parameters after rotational vestibular stimulation using outcome measures.

Methods:

- **Study design:** Randomized Controlled Trial
- **Type of study:** It will be an experimental study.
- **Setting:** MGM School of Physiotherapy, Aurangabad.
- **Sample size_** 30 calculated based on prevalence of ADHD in school going children using G power

Materials:

- Bosu ball
- Swiss ball
- T swing
- Square swing
- Tilt board
- Platform swing

Participants:

Inclusion Criteria:

- Age between 6-10 years.
- Down syndrome children with balance affection.

Exclusion Criteria:

· Children with Downs syndrome with cardiac illness like Atrial Septal Defect, congenital heart defect, Tetralogy of Fallot, etc.

· Children with Downs syndrome with Atlantoaxialinstability.

· Children with Down syndrome with any orthopedic deformity, nystagmus, aversive response to movement.

· Children with Downs syndrome with severe mental retardation,IQ=20-35.

Variables:

Outcome Measures:

Name, Age, Gender, Gestational age, Prenatal history, Perinatal history, post-natal history and Drug Therapy will be recorded prior to the intervention with the use of following scale.

1. Movement Assessment Battery for Children (M-ABC)-

In this test general motor ability of children was measured. This test is designed to identify and describe the impairment in motor performance of children of 4-12 years of age. According to the Movement-ABC manual the test has acceptable Validity and reliability. The test reliability ranges from 0.70-0.89. The component of this scale include Balance which was further subdivided into 3 categories in which only the balance performance of the children was being focused. The total score of the scale ranges from 0-40. As the highest score indicates poor balance in the children⁽¹¹⁾.

2. Bruininks - Oseretsky Test of motor proficiency (BOT)-

Scale was used to assess gross motor skills with age group of 4-11 years. It includes components such as Balance with score of 32 points, running speed and agility with 15 points, bilateral co-ordination with 20 points and strength with 20 points. Reliability of scale range from 0.60-0.90⁽⁴⁾.

3. Pediatric Balance Scale (PBS) -

Pediatric Balance Scale is used to measure the balance in such a way that minimal assistance is required with specialized equipment. The scale is performed in the children with the age group of 4-12 years. Pediatric Balance Scale is a reliable measure of functional balance in the children with mild to moderate motor impairment. The test reliability ranges from 0.89-0.99. The component of the scale included were 14 which were the task performed routinely by the children in day-to-day activity. Pediatric Balance Scale incorporates 0-4 grading scale to assess the performance. The total score ranges from 0-56. The highest score indicates no affection in balance and least score has affection of balance in children⁽¹²⁾.

Study Size:

Expected Results:

Once the data will be collected and statistical analysis will be done.

Significant Improvement may be seen in improving balance using sensory integration therapy. However, in previous researches on rotational vestibular stimulation was no statistical improvement in balance due to small treatment duration. In this study, the duration of treatment will be increased and large sample size will be used as compared to previous study on rotational vestibular stimulation. Hence, this study will help in investigating whether there will be improvement in balance using Rotational Vestibular Stimulation or not.

Discussion

The vestibular system is important for achievement of normal motor development and coordination. Vestibular dysfunction leads to motor discoordination. The vestibular system is one of the wide sensory system. Improving balance is important as it has several beneficial roles in an individual's life. Improvement in balance leads to reduction in fear of fall which increases confidence amongst the children and increases their participation in various functional activities. Many

studies have been done on balance in past years. Such studies revealed improvement in balance in children with down syndrome. These studies were conducted using techniques such as Neurodevelopmental Technique, Sensory Integration Therapy, Treadmill training, etc. But these studies faced some limitations such as inadequate sample size, inadequate treatment time, environmental disturbances during treatment, etc. However, in this study we will be eliminating these barriers by increasing the duration of session per day as 1.5 hours a day, frequency will be increased as 3 days per week, total duration of the treatment will be extended for 3 months. Moreover, this study will employ widely used methods of assessment which have appropriate reliability and validity as well as accepted by researchers, found in literature and research papers

Conflict of Interest - there is no conflict of interest

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Ethical Clearance taken from Institute

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