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Use of obstacle gait training to improve balance in children with developmental delay: A single case study

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Abstract
Balance is one of the major component of the development of the brain. Balance impairment is a common complaint in children with developmental delay and hypotonia as they lack muscle control. The purpose of this study is to find out the effect of obstacle gait training to improve balance in pediatric patients. A 3 year old baby presented to physical therapy when she was 6 months old by the primary care giver as she was having global developmental delay and hypotonia. She is undergoing physical therapy treatment for 6 days/week. She regained normal muscle tone but the balance was still affected. She presented to skilled outpatient therapy where she was seen for 6 times per week for three weeks. Her primary care giver complained that she avoids activities that requires her to balance. PBS was used to assess the pre and post-intervention values. Her PBS improved 11 points post-intervention. She was able to ascend the stairs independently and was able to initiate to descend the stairs independently. Obstacle gait training was found to be beneficial in improving this patient's balance. This case report gives insight to clinicians to improve balance with the use of obstacle gait training. This study concludes that use of obstacle gait training in conjunction with the conventional rehabilitation program improves balance in children with developmental delay.

Keywords: Obstacle gait training, balance, developmental delay, children

Introduction
Balance is one of the major component of the development of the brain and cerebellum functions to control balance and equilibrium. Balance is largely divided into static and dynamic balance wherein the former is the ability to maintain postural stability at rest and the latter is the ability to maintain the postural stability during the movement [1]. When used effectively, it helps children acquire and maintain proper controlled body movement throughout job performance, which, when done well, minimizes weariness. A child with high balance and coordination is less likely to sustain an injury because they are more likely to respond when necessary with the appropriate postural alignment.

Balance and coordination are physical qualities that also enable proper posture for later success at fine motor activities. Vision, vestibular function, and proprioception are three crucial senses that work in intricate interactions and central mediation to maintain balance. At birth, the sensory systems that influence balance are structurally fully developed. Between the ages of three and six, balance control shifts from being largely visual-vestibular to being somatosensory-vestibular, but the transition to adult responses for all sensory circumstances is not complete by this time. It takes until at least 10 to 15 years of age to develop the coordination of postural responses. Between the ages of three and six, the capacity to maintain head stability during loco motor tasks develops, eventually maturing into an adult capacity as visual predominance declines and vestibular function rises. An active sensorimotor control system is required for maintaining postural balance. Adults have well-developed sensory systems that respond appropriately to their surroundings. Despite their early maturation of their anatomical components, children's sensory systems are not fully formed. Proprioceptive, visual, and vestibular systems mature later in childhood than automatic motor processes, which grow more slowly. Adults prioritize somatosensory signals in balance regulation, but children prioritize visual inputs over vestibular information when achieving postural balance [2, 3].

Balance impairment is a common complaint in children with developmental delay and children with hypotonia as they lack muscle control. Children who have developmental delay and are ambulant aim to function well to be able to participate in the activities with other children. Gait requires the capacity to maintain balance both when moving weight and when it is motionless. For tasks like gait initiation and sit-to-stand, one must shift their center of gravity between their legs and closer to their stability limitations. Due to the increased risk of falling in these circumstances, this area of balance may be more crucial for mobility in daily life [4]. The commonly used outcome measure to evaluate the balance of a child is the pediatric balance scale which is similar to berg balance scale (BBS) used for adults. In order to navigate complicated, cluttered, environments while engaging in daily activities like work and play, it is necessary to be able to integrate the sensory information.

It is necessary for the brain to have systems for representing an obstacle's characteristics (size, direction, movement, etc.), for representing the obstacle's location in relation to the body, and for updating these representations as the body moves. Knowledge of the mechanics of the loco motor system and the control techniques utilized during this activity are necessary for comprehending and recognizing the risk factors for tripping, which are essential in the prevention of falls. The kinematics and kinetics of barrier crossing in healthy humans have been extensively studied by Begg *et al*. (1998), Chen *et al*. (1991), Weerdesteyn *et al*. (2005), and the role of vision in obstacle avoidance tasks (Patla and Vickers, 1997; Patla and Rietdyk, 1993). When faced with an obstacle, older adults adopted a "step-shortening" strategy, in contrast to younger adults who adopted a "conservatism" strategy and kept most of their walking parameters constant. The behaviour of the elderly was understood by Chen *et al*. (1991) and Weerdesteyn *et al*. (2005) as a safety strategy or as a challenge in understanding the sensory input offered by the impediment [5].

2. Case Report

A 3-year-old baby was brought to the pediatric OPD with a history of hypotonia and global developmental delay. According to the informant the patient had difficulty in controlling movements and had a fear of fall. When questioned about the issue, the informant revealed that the child was diagnosed with hypotonia at 6 months of age and given the doctor's recommendation to receive physiotherapy treatment. At the time of experiment the patient was able to independently stand and walk but had difficulty to maintain balance for a long time. She was able to ascend and descend the stairs with support. She had moderate limitations of sitting and standing balance (Pediatric balance scale: 31/56). The informant mentioned that there was no history of trauma during pregnancy to the mother of the child. On further evaluation of the developmental milestones of the patient it was observed that the patient had a delay in achieving gross motor milestones and the highest milestone at the time was of walking, delay in the fine motor milestone, the highest milestone being removing socks and shoes and delay in language milestones. On examination of the patient’s posture, b/l knees were hyperextended and the ankle pronated. While assessing the gait of the patient it was revealed that there was no heel strike, the subject couldn’t maintain foot flat for a longer duration and weight shift was more on the right during midstance.

2.1 Physiotherapy Management

A 3-week, six-days-per-week physical therapy rehabilitation program was designed based on the subjective and objective evaluation. The main goal of the program was to improve the balance in order to prevent the risk of fall to the patient. The secondary goals were to improve the strength of the upper and lower extremities, reduce the navicular drop and improve the gait pattern of the patient. The program included the use of obstacle training which included a slide which had 3 steps to climb and a slope, a mattress, a stepper with two steps (height: 30.5 cm, length: 51.5 cm, breadth: 23.5 cm and the height between the two steps was 14.5 cm), a wedge and a basketball net (basket) along with the conventional training.

Fig 1: Obstacles used to improve balance

Fig 2: Patient walking on an uneven mattress

Fig 3: Patient climbing on a stepper without support

Fig 4: Patient climbing on a wedge

Fig 5: Overhead activity performed by the patient

Fig 6: Patient climbing the slide

2.2 Outcome Measure

The Pediatric Balance Scale (PBS), a modified version of the Berg Balance Scale (BBS), can be used to accurately assess balance in children with cerebral palsy, delayed development, and other neurological conditions (Darr *et al*., 2015; Verbecque *et al*., 2015). A 14-item, criterion-referenced assessment called the PBS looks at functional balance in the context of daily work. Using technology that is typically accessible in schools and clinics, it can be administered and scored in less than 20 minutes. Children with mild-to-moderate motor impairments have had their balance abilities assessed using the PBS. According to Darr *et al*. (2015) and Franjoine *et al*. (2003), the PBS has strong test-retest reliability [Intra-class correlation coefficient (ICC) =.998] and inter-rater reliability (ICC=.997) [6, 7, 8]. Pre and post intervention value of the same was taken in order to quantify the results. [Table 2]

3. Result and discussion

This study examined the effects of obstacle gait training on balance in children with developmental delay. The assessment was carried out by performing a thorough evaluation of the patient and comparing the values before and after the intervention, which revealed a considerable improvement in the patient's balance. There is lack of literature that provides us of the advantages of obstacle gait training on balance to lower

the chance of falling. Obstacle gait training is seldom ever used while creating a balance training program. Therefore, the current study focused on how obstacle gait training affected the capacity to balance in children with developmental delay [9].

Park *et al* studied the effects of a circuit training program on the walking and balance capabilities of stroke patients. The experimental group's BBS score increased in the comparison of balance ability. The results of this study show that incorporating obstacles in a circuit training program significantly improved the 10-m walking time, a measure of walking ability, as well as the BBS and the Timed Up and Go test, measures of balancing ability [10]. Another study conducted by Said *et al*. reported that motion of the joint increased after obstacle training in hemiplegic patients, and that the bending angle of the hip joint improved. This means that obstacle training is important for improving the balance skills associated with postural control [11].

Jeong conducted a research on task-oriented circuit exercise with obstacles using a sample of 30 stroke patients. In this study, the experimental group's BBS increased from 43.7±6.0 before the training to 45.2±5.3 after the training, statistically substantially more than the control group [12]. We hypothesize that practice of obstacle gait training must have improved mobility, increased obstacle clearance capacity, improved balance & reduced risk of falls, and improved the confidence in walking in children with developmental delay. Repeated practice of obstacle gait training increases the distance between foot, increases speed, and increases confidence during walking by reducing the fear to cross the obstacle. Obstacle training involves single leg standing which increases the joint proprioception sense thereby improving the balance.

Use of an obstacle doesn't have to be specific. The therapist can modify the obstacles depending on the availability and the comfort of the patient. In this study we made use of the slide, a soft mattress, a stepper, a wedge and a basket indulging the subject in a playful activity and thereby focusing on the target. However, obstacle training alone will not benefit the patients with developmental delay. It has to be incorporated with other conventional training program such as strength training, vestibular stimulation, facilitation and gait training. Obstacle training should be included as a part of the rehabilitation program to improve balance. The result of this study showed a clinically significant improvement in the pediatric balance score of the child with developmental delay.

Limitations of the study

Constraint treatment time.

Explanation of the procedure to the pediatric population.

Children with attention deficit.

3.1 Tables

Table 1: Physiotherapy intervention to improve the balance

Intervention	Intensity	Frequency	Duration
Obstacle training	1 set of 10 repetitions	6 days per week	18 sessions

Table 2: Change in the score of outcome measure

Outcome measure	Pre-intervention value	Post-intervention value
Pediatric balance scale	31/56	42/56

4. Conclusion

This study concludes that the use of obstacle training in conjunction with the conventional rehabilitation program improves balance in children with developmental delay.

5. Acknowledgment

The patient's cooperation in carefully adhering to the directions and consistently completing the task is appreciated by the writers. The institute's assistance and approval of this effort are also appreciated by the writers.

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