Impact of Gym Ball Exercise on Standing Balance in Children with Cerebral Palsy

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Abstract

Introduction: Cerebral Palsy (CP) is not a disease, but a non-progressive disorder that occurs in developing brain. CP has become the most common pediatrics problem which needs early medical diagnosis and intervention. CP children have balance difficulties because they are unable to perform their activities of daily living and have high risk of fall. Balance training using vestibular system, gym ball, and assistive devices is one of the main elements in the improvement of balance of CP children. The aim of this study was to identify the impact of gym ball exercise on standing balance in children with CP. **Methods and Materials:** A quasi-experimental study was conducted on 54 children diagnosed with either spastic, non-spastic, hemiplegic or diplegic CP. Gym ball exercises were regularly given to each participant for 3 weeks. Patient's standing balance was assessed by using Pediatric Balance Scale (PBS) before and after Gym ball exercises. Data was collected from the department of physiotherapy at (ACELP) Karachi. Paired-t test was used to compare the static balance before and after gym ball exercises. **Results:** There was no significant difference in standing unsupported between pre-exercise and post exercise (P=0.159). However, for other parameters including standing unsupported with eyes closed (P=0.00), standing unsupported with feet together (P=0.01), standing unsupported one foot in front (P=0.00), and standing on one leg (P=0.01), significant reduction were found after the intervention compared with before the intervention. **Conclusion:** It was found that the gym ball exercises could significantly improve the standing balance of children with CP.

Keywords: Cerebral palsy; Gym ball; Swiss ball; Standing balance

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Introduction

Cerebral palsy (CP) is not a disease, but a non-progressive disorder that occurs in developing brain. CP has become the most common pediatrics problem which needs early medical diagnosis and interventions. The occurrence of this disorder is approximately 2 to 4 per live births (1).The exact prevalence rate of CP in Pakistan is not known, but the rate is high due to low socioeconomic status, thus CP is one of the most frequent reported pediatric developmental disorder in Pakistan(2).The risks factors of CP includes complicated delivery, methyl mercury exposure during pregnancy, and head trauma during initial years of life(3). Premature birth and low birth weight are one of the most important risk factors associated with CP, as reported by Sankarand Mundkur that 75-80% of the developing brain may injure in the prenatal stage(4). The causes for prenatal brain injuries include extreme prematurity, genetic disease, meningitis, hydrocephalus, and placental abruption(5).Infection and trauma may be the causes for perinatal injury. The causes for postnatal injury includes toxic ingestion, trauma, home-based deliveries of babies, and neonatal seizure(6).There are several methods to classify CP such as anatomical, physiological or functional, but most common method of classification is physiological classification with focus on the area of brain lesion that includes pyramidal (spastic) and extra pyramidal(non spastic) CP(7).

Balance is the ability of a person to keep the body in a stable position and return It from an unstable to a stable condition(8, 9). It also includes an upright standing position and dynamic balance (while performing various tasks like walking). There are some studies on upright standing balance of children with CP (10, 11). These studies investigated upright standing balance

Figure 1.A)Shows CP patient sitting on the gym ball; *B*)Shows sitting on the gym ball with the weight being shifted via sideways activity; *C*) Shows sit to stand by using gym ball; *D*) Shows one leg weight bearing on gym ball

in different positions like tandem and normal stances or in variable sensory conditions like standing with eyes opened and closed(12, 13).CP children have balance difficulties because they are unable to perform their activities of daily living and have high risk of fall.(2)study of seven children with spastic diplegic CP and 14 age- and gender-matched nondisabled children evaluated their static standing balance under altered sensory environments. The results suggested that the children with spastic diplegic CP may have difficulties in resolving intersensory conflicts for maintenance of standing balance(14).Evidence suggested that the role of physiotherapy treatment in the management of CP patient can be beneficial to make their daily living activities easier and their life effortless. The main goal of management of CP patients should be to prevent further complications and to increase functional capabilities(15, 16).Evidences based researches put forward that physiotherapy approaches in the treatment of CP patients is to improve muscle strength, muscle endurance, joint flexibility, and postural correction, to reduce spasticity, and to improve range of motion. A research indicated that balance training using vestibular system, gym ball, and assistive devices is one of the main elements in the treatment of CP children.(3, 17)The main purpose of this study was to evaluate the standing balance of CP children with the use of gym ball exercises.

Methods and Materials

An quasi-experimental study was conducted on children diagnosed with types of CP. Data was collected from the department of physiotherapy at Association of Child Emotional and Learning Behavior (ACELP) Karachi with the sample size of 54 CP patients. Participants were included in the study if they were diagnosed with CP either with spastic, non-spastic, hemiplegic or diplegic type, age ranges from 5-18 years old. Majority of patients (60%) needed supervision for ambulation. Participants were excluded from the study if they had any spinal disabilities, delayed milestones, any other syndrome, and meningitis. Purposive sampling technique was used to collect the data. Written informed consent was taken from patients' caregivers prior to study and patients were assured of their confidentiality which was approved by ethical review committee with ERC code KIPRS/R&D/ERC/2020-03. Standing balance was assessed by using Pediatric Balance Scale (PBS) prior to the intervention. Then, gym ball exercises were regularly used for a 3-week period and patients were reassessed again via PBS for standing balance after 3 weeks. No other interventions except gym ball exercises were given patients during this study.

Treatment Procedure

For the best possible outcomes, non-noisy, comfortable and friendly environment was given to the patients prior to treatment. Interventions given to the patients included 6 Gym ball exercises performed regularly for 3 weeks. A gym ball exercise included: 1.Ask the patient to sit comfortably on the gym ball with the feet supported on the floor, 2. Ask patient to sit with eyes opened and then eyes closed 3. Ask the patient to perform sit to stand on a gym ball with both feet together on the floor, 4.Ask the patient to sit on gym ball while weight was shifted to one leg and then to opposite leg, 5.Ask the patient to stand on the both legs with gym ball in front while weight was shifted via outstretched arms, 6. Ask the patient to stand on one leg while opposite leg was placed on the gym ball in front and procedure was repeated for the opposite leg(18).

Sitting on the gym ball

Figure 1, A shows that patient was asked to properly sit on the gym ball with the trunk straight, arms by the sides, both feet supported on the floor, and 90 degrees angle should be maintained at the hip, knee, and ankle. Therapist kneeled in front of the patient while using both hands to grip the patient's pelvis anteriorly.

Table1.The results of standing balance in children with CP in pre- and post-intervention

Variables	Pre-intervention		Post-intervention				*P*-value (difference between 2 test conditions)
	Mean (SD)	Std. Error Mean	Mean (SD)	Std. Error Mean	95% Confidence Interval of the Difference		
					Lower	Upper	
Standing unsupported	2.22 (1.92)	0.26	-0.03 (0.19)	0.02	-0.08	0.01	0.15
Standing unsupported with eyes closed	1.44 (1.48)	0.20	-0.44 (0.92)	0.12	-0.69	-0.19	0.00*
Standing unsupported with feet together	0.59 (1.35)	0.18	-0.18 (0.55)	0.07	-0.33	-0.03	0.01*
Standing unsupported one foot in front	0.51 (0.96)	0.13	-0.25 (0.64)	0.08	-0.43	-0.08	0.00*
Standing on one leg	0.37 (0.48)	0.06	-0.11 (031)	0.04	-0.19	-0.02	0.01*

*SD: standard deviation, * P<0.05 considered as significant*

Sitting with eyes opened and then eyes closed

To activate the proprioception, the patient was ask to sit on the gym ball with open eyes while the therapist counted for 10 seconds, nextask the subject to close the eyes for 10 seconds, and then relax.

Sitting on physio ball with weight being shifted

Figure 1, B shows that patient sat on the gym ball with the trunk straight, both hands by the sides while 90 degrees angle maintained at the hip, knee, and ankle joints and feet together on the floor. Therapist sat in front of patient at the level of his knees. One hand was placed to maintain the body alignment while other hand was used to engage the patient in initially to one side and then to the side and allow the patient to shift his weight to both sides alternatively.

Sit to stand

Figure 1, C shows the patient sat on the gym ball in associated with the proper body alignment with the trunk straight, arms by the sides, 90 degree angle at the hip, knee, and ankle joints, feet together on the floor. Therapist kneeled in front of the patient to provide support. The patient was ask to stand while shifting weight on the both feet together, then to sit, and to repeat the procedure for few repetitions.

Standing with gym ball in front

Have the patient in standing position with both feet placed on the floor with the knees straight knee or those is can be used to correct the knee alignment), therapist stands behind the patient to provide support, place the gym ball in front of the patient. Ask the patient to lean forward on the gym ball with both hands via out stretched arms.

One leg weight bearing on gym ball

Figure 1D shows the patient in standing position wearing the knee or those is to keep the knees straight. The rapist stood behind the patient while gripping the patient's pelvis via both hands to provide support. The patient was asked to stand on one leg to bear the total body weight on it while other leg was stretched on the gym ball.

Statistical analysis

Based on normality test, the data distribution was normal. Therefore, paired-t test was utilized to evaluate the static balance of children with CP before and after gym ball exercises. All statistical analyses were performed by using SPSS Version 22 with the p-value of significant if it was less than 0.05.

Results

Table 1 shows results of paired sample test that includes pre-intervention and post intervention.There was no significant difference in standing un-supported between pre-exercise and post exercise (*P*=0.159).However, for other parameters including standing unsupported with eyes closed (*P*=0.00), standing unsupported with feet together (*P*=0.01), standing unsupported one foot in front (*P*=0.00), and standing on one leg (*P*=0.01), significant reduction were found after the intervention compared with before the intervention.

Discussion

Ability to maintain the static balance while doing many activities of daily living in very important in human beings.

Preliminary aim of this study was to find the impact of gym ball exercise on standing balance in children with CP. Results of this study showed that standing unsupported with eyes closed (vestibular plays a major role), standing unsupported with feet together, standing unsupported with one foot in front, and standing on the one leg were significantly decreased after the therapeutic interventions with gym ball exercises. This finding was consistent with the study which found that there was an improvement in standing balances by using the gym ball (19).The present study also found that there was no significant difference in the standing unsupported. In another study, they found that Plinth and gym ball based trunk exercise regimes resulted in a significant improvement in static balances (20).

Another study found that there was a significant improvement on static balance as well as dynamic balances on 10 to 12 years soccer players by using Swiss ball for balance training(21). Another study also indicated that Swiss ball trunk exercise could improve trunk control, functional balance, and walking in stroke patients in the early stages of recovery. The literature indicates that children with CP present a lower postural balance ability compared with typically developing children (22-24).Velocity and center of pressure sway, mainly in the medial-lateral direction, exhibit the greatest increases in patients with CP (23, 25).This study suggested that standing balance of children with CP was significantly improved by gym ball exercises. The present study can provide an evidence to use gym ball exercise as an essential tool to improve balance of CP child for physiotherapy management.

There are several limitations of this study that should be noticed. Sample size was so small. Thus, this study did not focused effect of gym ball exercises on different types of CP separately. The wide age range was addressed in the current study, thereby causing bias in the results. The duration of the training program was also short i.e., only 3 weeks that it showed only short-term improvement. Another study can be conducted to find out the effects of gym ball exercises with longer follow-up on different types of CP.

Conclusion

Gym ball exercises showed significant improvement in standing balance of children with CP. Maintaining balance has important impact on activities of daily living, gait, and lower risk of falling. Therefore, balance training can prove to be essential part of regular physiotherapy management in children with CP for their independent activities of daily living.

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All authors made substantial contributions to the conception, design, analysis, and interpretation of data.

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