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Original Article

Effects of Standing Board on Antigravity Muscles in Children with Cerebral Palsy Aging between 3 to 10 Years; A Multi-Centered Randomized Control Trial

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ABSTRACT

Cerebral palsy is one of the most common conditions contributing to childhood motor disability. It is usually categorized by a diverse range of gait abnormalities making ambulation very challenging. Standing board/frame has been a widely used physical therapy intervention practiced globally. **Objective:** To evaluate the effect of a standing board on the antigravity muscles among cerebral palsy children aged between 3 to 10 years. **Methods:** A 6-months experimental study was conducted in Karachi, Pakistan on children suffering from cerebral palsy. They were assessed for weight-bearing status, alignment, and range of motion of the child's hip and knee joints based on varying positions. **Results:** After 6 months of intervention, the ROM and muscle strength grading in groups X and Y remained unchanged. The mean duration of standing with support increased to 20.2 min and 19.3 min and without support to 9.5 min and 6.7 min, respectively. **Conclusions:** The use of a standing board amongst CP children with non-ambulatory status is much more apparent when used daily for at least 45 minutes. It is more effective in correspondence to the alignment of the hip and knee joints.

INTRODUCTION

Cerebral palsy (CP) refers to a group of non-progressive, permanent lesions of brain incongruity during fetal life leading to physical and intellectual impairment that influence not only the posture and voluntary movement but also impacts the capacity to perform voluntary and impactful movements and ambulation [1,2]. The global prevalence of CP ranges from 1 to nearly 4 per 1,000 live births. Approximately 1 in 345 children have been identified with CP in the United States [3]. The number of CP cases is on a rising trend in low- and middle-income countries (LMICs) like Pakistan and yet remain underrepresented [4]. Compared to the global average, it is estimated that in Pakistan, 4 children out of 1,000 suffer from CP. The causes for the high prevalence of CP cases in Pakistan are a lack of antenatal care and a high burden of infections during childbirth [5]. The characteristic features of CP include spasticity, reduced muscle strength, contractures, and bony abnormalities, leading to a non-ambulatory status in patients [1]. The treatment approaches used for the management of this condition are supportive care along with physical therapy, occupational therapy, speech therapy, and behavioral therapy. The role and the primary goal of physical therapy treatment is to strengthen muscles, prevent contractures, encourage mobilization

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[6], and initiate weight-bearing activities to help reduce the risk of fractures by improving the BMD in children with CP and make patients functionally independent [7]. Furthermore, a comprehensive treatment approach is beneficial for multidisciplinary management of cerebral palsy. As this condition greatly varies according to severity, type, and degree, the management plan should be focused on the individualized assessment and management approach that are innovative techniques supported by evidence-based regimes [8]. The patient's weight-bearing status is achieved with exercises that strengthen antigravity muscles using standing frames or standing boards as balance is an essential component of gross motor functioning and for the performance of activities of daily living [1, 9]. Practitioners rely on their judgment to determine the duration and frequency of its use and the type of device under usage [10]. Despite the growing interest in standing board therapy, there's a lack of comprehensive evidence on its effectiveness, especially regarding the optimal frequency and duration of treatment in the challenging settings of Pakistan [11]. Existing studies have provided some insights into the potential benefits of standing board therapy, but there's a need for rigorous, well-designed clinical trials that evaluate the efficacy in a controlled setting. This multicentered randomized study aims to address this gap by investigating the effect of standing boards on antigravity muscles and analyzing the frequency and duration of standing. The objective of the study is to generate a standardized program for standing board use in CP patients from 3 to 10 years across Pakistan that can assist the medical personnel in the practice measures that can improve the management in difficult circumstances. Also, it can greatly influence rehabilitation strategies and contribute to enhancing the functional outcomes and quality of life of children with cerebral palsy.

METHODS

An experimental study was conducted from July to December 2022 for 6 months at two institutes catering to special needs children in Karachi, Pakistan. This study assessed the weight-bearing status, alignment, and range of motion of the child's hip and knee joints based on various positions. Children born and diagnosed with cerebral palsy were included in the study. Children who showed a non-ambulatory status for the past six to eight months were inducted. The age range was set at 3 to 10 years as the institutes that were used for sampling worked with children in this age group during each session of standing board therapy. One major criterion considered in the study was head holding and the child's control overhead motion. Any child that showed scoliosis, trunk abnormality, or lower limb contractures was excluded from the study. It was made sure that children with primary disorders of the spinal cord were diagnosed and excluded from the study as well. The sample size was set at 20 considering the availability of the children and the unattainability of consenting guardians for the child to be included in the study. The study population was equally divided into two groups namely, "X" and "Y" using a simple random sampling method. This division was based on the frequency of physical therapy sessions conducted using standing board therapy. The former received sessions daily, while the latter had alternative day sessions. Questionnaires were provided to the physical therapists that were divided into pre- and post-standing board use. Firstly, the range of motion was assessed in the initial section outlined at the hip and knee joint in degrees, secondly, the muscle strength grading scale was used for assessing lower limb muscular strength grade. The grading was done from 0 to 5; 0 for no muscle contraction, 1 for a flicker of contraction, 2 for muscle movement with gravity, 3 the movement against gravity but not against resistance, 4 the movement against gravity, and some resistance, 5 was the active movement against gravity and resistance. Lastly, the child's behavior was also gauged through observation by the therapist where mood changes and concentration on the activity performed were assessed based on performance. A standing board with adjustable height and support for the upper and lower limbs was used. The participants of group X were engaged in the standing session initially starting for 20 minutes daily. Similarly, the participants of group Y received the treatment sessions on alternate days. The duration of the standing session was gradually increased to a maximum of 45 minutes during the trial, based on individual tolerance and progression. The participants were positioned using straps and support for maintaining upright posture and positioning. A trained physical therapist supervised the standing session ensuring positioning and safety protocol. Patient tolerance, adherence, and any adverse events were monitored regularly during and after each session.

The intervention in this randomized control trial consisted of 6 months of structured protocol using the standing board for the assessment of the ability of the study participant to be able to sit without support and hold the standing frame with support and also helped in the assessment of changes in the dimensions of joint alignment. A baseline assessment was conducted before the initiation of the intervention and the follow-up session was performed. The later section of the questionnaire outlined the child's performance on the standing board and measured changes in the range of motion and muscle strength. This questionnaire recorded the timeframe the child was able to sit with and without the support and the

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time the child could hold a standing position with support. Data was gathered on Microsoft Excel and after basic data cleaning and coding, it was transferred for analysis to SPSS version 24.0. Data analysis included running measures of central tendency on continuous variables like time duration of standing and sitting with and without support. For comparing the outcomes before and after the intervention, paired t-tests were used. To compare the outcomes between the two groups after the intervention, independent t-tests were used. Written consent for data collection was attained from the institutions stating all the risks and benefits of the study. Moreover, consent was also attained from the guardian of each participant. This was a minimal-risk study. The participants were not exposed to any interventions or clinical tests. One potential risk, however, could be a breach of information. However, all measures were taken to ensure that no such breach occurred. The privacy of the participants were ensured during the consent session. Data were uploaded on the secure servers and downloaded for analysis on a password-protected file on the computer of the study PI. Personal information of the participants were not disclosed or used in the data. Any publications from the study will report the result in the aggregate.

RESULTS

Twenty children with a diagnosis of Cerebral Palsy were recruited to participate in the study. The mean age of the participants was 5 years. The participants were further divided equally into two groups, X and Y, based on the frequency of standing board therapy. Both groups received standing board therapy for forty-five minutes with Group X receiving daily therapy and Group Y receiving therapy on an alternate basis. Before the intervention, descriptive statistical analysis of Group X showed that the range of motion (ROM) at the hip and knee joint was 69 degrees with grade 3 muscle strength. Similarly in Group Y, the ROM at the hip and knee joint was 63 degrees with grade 3 muscle strength. After 6 months of intervention, the ROM and muscle strength grading in groups X and Y remained unchanged (Table 1).

Table 1: Comparison of pre-and post-intervention between Group X and Y

Group	ROM	Muscle Strength	Muscle Alignment	Mean Duration Standing with support min (%)	Mean Duration Standing without support min (%)
Pre- Intervention					
X	69	3	-	9 (20)	4.5 (10)
Y	63	3	-	6.7 (15)	2.2 (5)
Post- Intervention					
X	69	3	Improved	20.2 (45)	9.5 (21)
Y	63	3	Improved	19.3 (43)	6.7 (15)

Before the intervention, the mean duration of standing with support in groups X and Y was 9 min and 6.7 min respectively, and without support in groups X and Y was 4.5 min and 2.2 min respectively. Similarly, after the 6-month intervention, for groups X and Y, the mean duration of standing with support was 20.2 min and 19.3 min, and without support was 9.5 min and 6.7 min respectively (Figure 1).

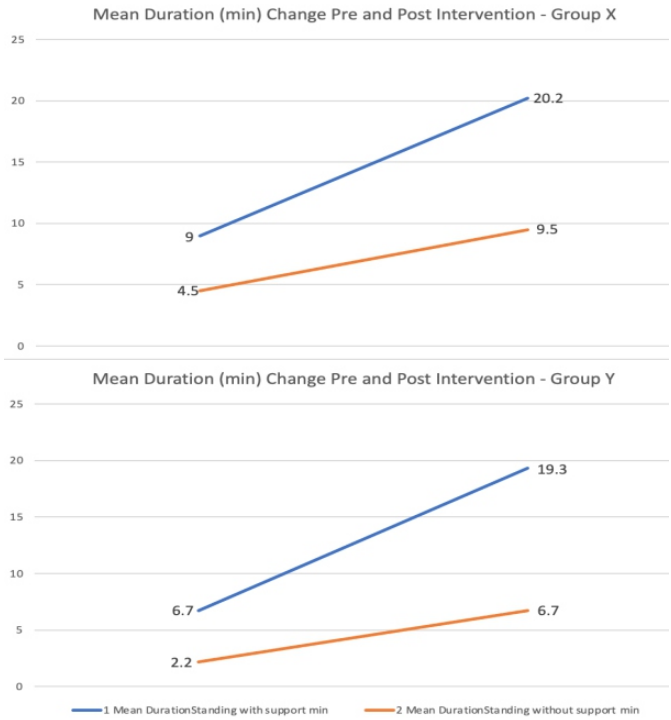

Figure 1: Mean Duration (min) Change Pre- and Post-Intervention

Qualitative analysis showed that a child's behavior impacted the most standing duration. In conditions when the child was distracted and relaxed, the duration of standing with support continued until the end of the session. While agitated and crying children had an increased tendency not to complete the therapy session.

DISCUSSION

Antigravity muscles play a dominant role in the motor functioning of individuals with cerebral palsy by maintaining posture, controlling movement, and most importantly facilitating standing, walking, and reaching activities [12]. Movement deficit and lack of muscle control due to weakening progressing to the development of postural deformities are trademark characteristics among children with cerebral palsy even though they may not have these structural abnormalities at the time of birth [13, 14]. Standing boards and frames have played a crucial role in promoting antigravity muscle strength and improving functioning by addressing musculoskeletal issues. They

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facilitate by promoting weight-bearing, improving the strength and tone of the musculature, improving the joint alignment and the range of motion reducing postural asymmetries, avoiding contracture formation, and improving the functional capacity by promoting activities of daily living [15, 16, 17]. If the antigravity musculature is not functioning properly, it can impact not only activities of daily living but also can lead to challenges in posture maintenance, initiation of movement, and most importantly ambulation and mobility [18, 11]. This study investigated the effects of using of standing board on the anti-gravity muscles in children with cerebral palsy(CP)and analyzed the outcome variable among study participants receiving the therapy daily and, in the group, receiving it on alternate days. The interventions involved using a standing board for 45 minutes daily for 6 months. The study concluded that this intervention did not impact the antigravity muscles, although there was a significant increase in the mean duration of standing with support and standing without support. There is extensive literature supporting the beneficial role of standing boards in patients with CP. Evidence has shown that static weight-bearing in a standing frame can increase bone density in children with CP [1]. Another study found that standing boards could retard bone loss in non-ambulatory CP children, control lower extremity contractures, and facilitate bone development [10]. Also, the duration and progression of treatment are said to boost the bone density and alignment of the ligaments that facilitate the movements at the upper and lower limb levels. Moreover, supported standing in an upright posture facilitates reduced muscular spasticity and improves muscular tone contributing to improved flexibility and muscular stiffness that encourages overall movement and ambulation [19]. Musculoskeletal deformities and postural asymmetry are said to be one of the main underlying factors associated with the formation of the wide swept-away pelvis and hip structure due to sedentary behavioral patterns and ambulatory status [11, 18]. However, following the standing board trial and its impact on the anti-gravity muscles significant improvement was observed in the hip and knee joint alignment that used the standing board daily during the trial. Also, they were able to stand for a longer duration with support. This suggests that daily use of standing board frames can positively impact joint alignment and standing ability. Evidence suggests that using the standing frame for a longer duration and more than 5 days a week is significantly associated with substantial lengthening of hamstring musculature [20]. Furthermore, a notable shortening of the hamstring was apparent after six weeks of no standing, highlighting the importance of continuous standing to maintain muscle length. The study findings also reported noteworthy improvement in activities of daily living (ADL) after using a standing frame, indicating functional benefits associated with standing interventions. However, it is important to note that the frequency and duration of treatment with standing boards and frames should be tailored according to the individual need and tolerance level. Also, these factors are vital for the progression of treatment of each CP patient. A multidisciplinary approach is essential to optimize the use of devices and maximize the benefit of CP treatment. Despite the positive findings, the study failed to record any significant impact on the antigravity muscles. The small sample size and the duration of the study were some of the factors affecting the generalizability of the study. Additionally, the study also faced challenges related to personal and environmental factors that influenced treatment outcomes. Children's pain and discomfort were significant factors affecting the cooperation, which impacted the findings of the study.

CONCLUSIONS

The study concluded that the daily usage of a standing board is more effective in the alignment of the hip and knee joints than its use on an alternate basis. A larger sample size and blinding of the participants performing the assessment would increase the validity of the findings. There is a need for further research to take place to standardize the duration and frequency of the standing regime. Presently, the regimen is decided on the physical therapist's expert opinion and is not less than forty-five minutes. Standing board therapy and other treatment modalities including orthosis, could yield the best possible outcomes in children with Cerebral Palsy.

Authors Contribution

Conceptualization: AF, MO
Methodology: AF, MO
Formal analysis: BZ, MZ
Writing-review and editing: MA

All authors have read and agreed to the published version of the manuscript.

Conflicts of Interest

The authors declare no conflict of interest.

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