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Role of three side support ankle–foot orthosis in improving the balance in children with spastic diplegic cerebral palsy

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Abstract Cerebral palsy (CP) is a heterogeneous group of permanent, non-progressive motor disorders of movement and posture. Ankle–foot orthoses (AFOs) are frequently prescribed to correct skeletal misalignments in spastic CP. The present study aims to evaluate the effect of the three side support ankle–foot orthosis on standing balance of the spastic diplegic CP children. Thirty spastic diplegic CP children participated in this study from both sexes. They were divided randomly into two age and sex matched groups: (*Group I*: study group and *Group II*: control group). The degree of spasticity was evaluated by passive movement for both limbs, while the child was completely relaxed. The Biodex stability system, was used for the assessment of the dynamic postural control of all diplegic children. Also the system measures the subject's ability to control the platform's angle of tilt. The patient's performance is noted as stability index which represents the variance of the platform displacement in degrees. Every patient in the study group was exercised on three side support ankle–foot orthosis for 30 min, three times weekly, for 6 months, also they received the same therapeutic exercise program which was given to the control group. The results revealed no significant difference as regards the pre-treatment mean values of all stability indices in both the control and the study groups ($P < 0.05$). However comparison between post-treatment mean values of all stability indices in both groups showed significant improvement in favor of the study group

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($p < 0.05$). In conclusion: Uses of the three side support ankle–foot orthosis in addition to physical exercise program is highly useful in rehabilitation of spastic diplegic cerebral palsy children as they enabled them to gain more balance control and postural reactions .

1. Introduction

Cerebral palsy (CP) is a heterogeneous group of permanent, non-progressive motor disorders of movement and posture caused by chronic brain injuries that originates in the prenatal, perinatal, or postnatal period [1]. It is also the clinical presentation of a wide variety of cerebral cortical or sub-cortical insults occurring during the first year of life and the most prevalent cause of persisting motor function impairment with a frequency of about 1/500 births [2]. In developed countries, the prevalence rose after introduction of neonatal intensive care, but in the past decade, this trend has reversed. The commonest cause of CP remains unknown in 50% of the cases; prematurity remains the commonest risk factor [3]. Children with CP suffer from multiple problems and potential disabilities such as mental retardation, epilepsy, feeding difficulties, ophthalmologic and hearing impairments [2]. A traditional classification of children with spastic CP includes spastic diplegia (bilateral spasticity with leg involvement greater than arm), spastic hemiplegia (unilateral spasticity), or quadriplegia (bilateral spasticity with arm involvement equal to or greater than leg) [4].

The diagnosis of CP is based on a clinical assessment, and not on laboratory testing or neuroimaging [5]. In clinical practice, the diagnosis of CP is typically based on observations or parent reports of attained motor milestones, such as sitting, pulling to stand, walking, evaluation of posture, deep tendon reflexes and muscle tone, particularly among infants born prematurely. Many clinicians avoid basing the diagnosis on a single aspect of the parent's report or the clinician's examination because the neurological findings are subject to interexaminer variation, with regard to both the methods used to elicit the neurological findings and the interpretation of the findings, and because neurological abnormalities may be transient [4].

Static and dynamic balance reactions of children with CP are poorer when compared with those of typically developed children. As balance skills are an integral part of gross motor abilities, poor balance causes difficulty with functional tasks involved in activities of daily living [6]. Postural reactions aim in the maintenance of balance, which means under static condition, the center of pressure (COP) (the center of the vertical force exerted by the feet on the platform) [7] and the projection of the center of gravity remain inside the base of support [8]. Base of support was defined as the perpendicular distance from the heel point of one footfall to the line of progression of the opposite foot. This is thought to be an important variable in the maintenance of stability [9], so base of support of the object is correlated to the amount of stability and balance, so the larger the base of support, the more the balance will be [10]. Rehabilitation of the patient with cerebral palsy depends upon the restoration of muscle balance, proper alignment of joints and establishment of correct posture in the line of gravity. No therapeutic program can succeed without attaining these goals [11].

Orthoses are part of multimodal therapeutic programmes together with other medical, surgical and therapeutic interventions [12]. Balance impairment seen in spastic diplegic children affects their functional level particularly standing and walking activities which may produce abnormal motor behavior that may require support [13]. Ankle–foot orthoses (AFOs) are frequently prescribed to correct skeletal misalignments in spastic CP, and to provide a stable base of support which helps in improving the efficiency of gait training [14]. Three side support may be effective to gain balance and proper body alignment. So the present study aims to evaluate the effect of the three side support ankle–foot orthosis on standing balance of the spastic diplegic child.

2. Subjects and methods

Thirty spastic diplegic cp children participated in this study from both sexes. They were selected from the pediatrics out-patient clinic of the Faculty of Physical Therapy, Cairo University. Their ages ranged from 3 to 6 years old. They were divided randomly into two groups: *Group I: Study group*: included 15 children (10 boys and 5 girls) with mean age ranged from 4.801 ± -0.77 years. They received the same therapeutic exercise program which was given to the control group, in addition to exercising with the three side support ankle–foot orthosis for about 30 min every session, three times weekly, day after day for successive 6 months. *Group II: Control group*: included 15 children (10 boys and 5 girls) with mean age ranged from 4.401 ± 0.69 years, and they received the therapeutic exercise program only.

2.1. Choice of sample

- *The subjects were selected according to the following criteria:*
  1. Spasticity grades ranged from 1 to 2 according to modified Ashwarth scale [15].
  2. IQ level not less than 70% which is the borderline in Wechsler's intelligence classification scale [16] in order to understand and follow orders.
  3. All subjects did not have fixed deformity of both lower limbs.
  4. All subjects were able to stand with support.
  5. All subjects did not have visual or hearing defects.

2.2. Instrumentations

Instrumentation included:

2.2.1. A. Equipment used for evaluation

1. *Modified Ashwarth scale*: adapted from Bohannon and Smith, 1987 [15].

2. *Biodex Stability System*: The Biodex stability system, was used to test the balance of all the subjects. It consists of a movable balance platform which can be set at variable degrees of instability. The system is interfaced with computer software monitored through the control panel screen and with Cannon Bubble Jet Printer to print the test results.

2.2.1.1. The components of the Biodex stability system include.

1. The foot platform: It provides up to 20 degrees of surface tilt in 360 degree range The platform diameter is 21.5 inches. It has a foot grid for determination of foot position, which is important for centering process of the subject before testing.
2. The alphabetic letters appear on the surface of the foot platform,from a–p (on the far ends of both sides) with parallel lines joining between them. While on the lower most part of the platform surface the numbers from 1–21 appear with 21 parallel lines joining between them. Letters and numbers lines are used to measure the heel coordinates.(Fig. 1)
3. Angles from 0 to 45 with the lines which represent these angles appear on the upper most part of the surface of the platform .These lines are used to measure foot angles.

2.2.1.2. The control panel screen.

- *Stability levels*: Biodex stability system allows for eight stability levels, which range from stability level one to stability level eight. The chosen stability level is selected on the screen, which allows setting up of the test parameters. Stability level eight is the most stable level as it allows the highest level of stability by making the platform to be least easily tilted. On the other hand, stability level one is the least stable level and it becomes more difficult for the subject to maintain stability.
- *Stability indices (SI)*: The system measures the subject's ability to control the platform's angle of tilt. The patient's performance is noted as stability index. The stability index represents the variance of the platform displacement in degrees. A high number is indicative of a lot of motion, which indicates balance problem. The system supplies the data regarding the balance of the tested subject. These data include anteroposterior (AP) stability index, mediolateral (ML) stability index and overall stability index. The smaller the amounts of sway, the lower the numerical value of stability indices.
- *Overall stability index*: Represents the variance of the foot platform displacement in degrees, from level, in all motions during the test. A high number is indicative of a lot of movement during this test.
- *Anteroposterior (AP) stability index*: Represents the variance of the foot platform displacement in degrees, from level, for motion in the sagittal plane.
- *Mediolateral (ML) stability index*: Represents the variance of the foot platform displacement in degrees, from level, for motion in the frontal plane.

2.2.2. B. Equipments used for treatment

2.2.2.1. Three side support ankle–foot orthosis (AFO).

1. An ankle–foot orthosis (AFO) is an orthosis or brace (usually plastic) that surrounds the ankle and at least part of the foot. AFOs are externally applied and intended to control position and motion of the ankle, compensate for weakness, or correct deformities. This type of orthosis is generally constructed of lightweight polypropylene-based plastic in the shape of "L", with the upright portion behind the calf and the lower portion running under the foot. It is attached to the calf with a strap. The unbroken "L" shape of some designs provides rigidity [17].
2. We modified the AFO on the base, which indicated that the wider the base of support, the more the balance would be. So we added sides support in the front, behind and at the lateral side, (Fig. 2) to increase the base of support and to make the AFO more stable. These sides were made of light firm metal. Every patient in the study group was exercised for 30 min in every session, three times weekly, day after day, for successive 6 months. Also parents were taught how to use the three side support ankle–foot orthosis at home as a home program for at least one hour daily at home.

2.2.2.2. Instruments used at treatment program. Mat, rolls, medical ball, wedges, balance board and standing bar were used in the treatment program.

2.3. Methods

2.3.1. A. For evaluation

2.3.1.1. Spasticity evaluation. Modified ashworth scale was used [15]. The degree of spasticity was evaluated by passive movement for both limbs while the child was completely relaxed, lying supine on a mat with the head in mid position.

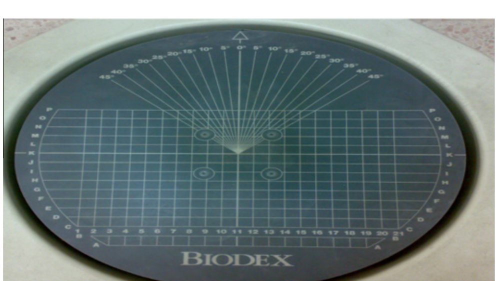

Figure 1 The foot platform.

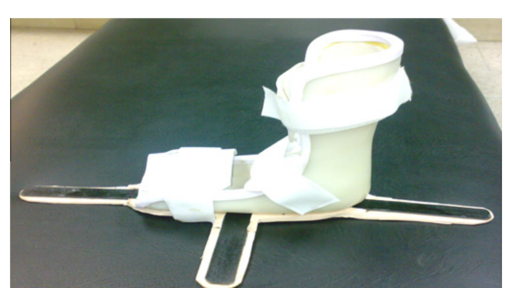

Figure 2 Single three side support ankle–foot orthosis.

The test was repeated 3 times and the mean record was taken to refer accurately to the degree of spasticity to select CP children having 1–2 grades.

2.3.1.2. The Biodex stability evaluation. It was used for the assessment of the dynamic postural control of all diplegic children before and after 6 months of treatment (using dynamic balance test). This test was performed to test the child's ability to control the platform angle of tilt, to measure overall, anteroposterior and mediolateral stability indices for all subjects. The aim of the evaluation was explained to every child and his parents before the start of the study. Each child was instructed to remove his or her shoes and step onto the foot platform of the device. The position and height of the handles of support were adjusted according to the subject height and comfort, to grasp it during learning the test procedures before starting the test.

2.3.2. Dynamic balance test sequences

All subjects were given an explanatory session before the evaluative procedure to be aware of the different test steps. Each child in both groups was asked to stand on the center of the locked platform with two legs stance. Safety support rails and biofeedback display were adjusted for each child to ensure comfort and safety. The display was adjusted so that the child can look straight at it.

2.3.2.1. The following test parameters were introduced to the device in this study.

- Child's height and chronological age.
- Platform firmness (stability level): All children were tested on the stability levels; level 8 (the most stable) and level 3 (less stable) during the same set of testing, beginning at level 8 and ending at level 3, for three time repetition for each trial. The mean of the three trials was calculated and recorded for each child individually before and after 6 months of treatment (All children were tested for 60 s for the three repetitions).
- Patient centering steps: It was performed to position the center of gravity (COG) over the point of the vertical ground reaction force. Centering was achieved by asking the child to stand on both feet, while grasping the handrails. The child was instructed to achieve a centered position on slightly unstable platform by shifting his feet position until keeping the cursor (which represents the center of the platform) centered on the screen grid while standing in a comfortable and upright position. Once centering was achieved and the cursor was adjusted in the center of the display target, instruction was given to the child to maintain his feet position till stabilizing the platform. This was followed by recording feet angles and heels coordinate from the platform. After introducing these angles into the Biodex system, the child was instructed to focus on the screen and the test then begins (Fig. 3). At the end of each test trial, a print out report was obtained. This report includes information regarding overall, mediolateral and anteroposterior stability indices. Every child was assessed before the application of the treatment program and reassessment was done after 6 months of using the treatment program.

Figure 3 Dynamic balance test for a child from the control group.

2.3.3. b. For treatment program

The control group: They received the designed therapeutic exercise program only.

The study group: The sessions of the designed therapeutic exercise program were conducted for six successive months, in addition to training with the three side support ankle–foot orthosis for about 30 min at the end of every session. Exercising using the three side support ankle–foot orthosis was done as follows:

1. Train the child to stand with the three side support ankle–foot orthosis alone by encouraging him to keep his or her balance during standing position.
2. Standing with the three side support ankle–foot orthosis on balance board to stimulate the child postural reactions.
3. Reaching exercise while standing with the three side support ankle–foot orthosis to facilitate the child balance and equilibrium reactions.
4. Stoop and recovery exercises.

The designed therapeutic exercise program used for the control and the study groups included the following:

1. Changing position exercises from prone to standing and from supine to standing position which enables the child to go within the normal sequence of movement up to standing position.
2. Kneeling and half kneeling on the mat to improve balance by fixing of the child legs in creeping position.
3. Manual standing on the mat grasping the child around his knees.
4. Manual standing on the mat with step forward and step backward grasping the child around both knees.
5. Standing on one limb on the mat then standing on the other.
6. Balance, equilibrium and protective exercise from standing on the mat by slightly pushing the child forward, backward and laterally to increase standing balance. Also the use of balance board and medical ball is useful to improve equilibrium, protective and righting reactions.
7. Strengthening exercises to weak muscles like dorsiflexors using manual resistive exercises.
8. Stooping and recovery exercising from standing position.
9. Squatting to standing exercise.
10. Gait training exercise between parallel bars using stepper.

Table 1 Age in years for both the control and the study groups.

Item	Patient's groups	X ± SD	MD	*t* Value	*p* Value	Significance
Age (Years)	Control group	4.401 ± 0.69				
	Study group	4.801 ± 0.77	0.4	1.488	>0.05	NS

N.B
X̄: mean.
MD: Mean difference.
t Value: unpaired *t* value.
SD: Standard deviation.
P Value: Probability value.
NS: Non significant.

11. Stretching exercises for tight muscles like hip flexors, hamstrings and calf muscles in lower limb and for wrist flexors, pronators and elbow flexors in upper limb.

2.4. Data collection

Overall, anteroposterior and mediolateral stability indices for all subjects were collected for both groups before and after 6 months of treatment program.

2.5. Statistical analysis

- The mean value and standard deviation were calculated for each variable measured during this study.
- Paired t-tests were calculated for each variable measured during the study. Note that the paired t test provides a hypothesis test of the difference between population means for a pair of random samples.
- We used level of significance 0.05 because the smaller the *P* value, the more strongly the test rejects the null hypothesis.

3. Results

3.1. Descriptive data of both groups (the control and the study)

It is worth mentioning that the ages (mean ± standard deviation) of control and study group were 4.401 ± 0.69 and 4.801 ± 0.77 years; respectively. Table 1.

3.2. The frequency distribution of sex in both groups (the control and the study)

The distribution of males and females in control group was the same for the study group which was 66.67% and 33.33%, respectively. As indicated from the pre treatment results of both the control and the study groups, all subjects were homogenous concerning age and sex. Table 2.

Table 2 The frequency distribution of sex in both groups (the control and the study).

Item	Control group	Study group
Males		
No	10	10
%	66.67%	66.67%
Females		
No	5	5
%	33.33%	33.33%
Total		
No	15	15
%	100%	100%

No = Number.
% = Percentage.

3.3. Comparison between pre-treatment mean values of overall stability index in both the control and the study groups

The mean values ± SD were 5.4 ± 0.834 and 5.52 ± 0.659 degrees for both control and study groups respectively which indicated no significant difference ($P > 0.05$) Table 3.

3.4. Comparison between post-treatment mean values of overall stability index in both the control and the study groups

The mean values ± SD of overall stability index for the control and study groups were 5.087 ± 0.835 and 4.36 ± 0.422 degrees respectively, which indicated significant difference ($p < 0.05$). The percentage of change was 14.29% in favor of the study group Table 4.

Table 3 Pre-treatment mean values of overall stability index for both groups (the control and the study).

Item	Patient's groups	X̄ ± SD	MD	*t* Value	*P* Value	Significance
Stability index (degrees)	Control group	5.4 ± 0.834				
	Study group	5.52 ± 0.659	0.12	0.437	>0.05	NS

Table 4 Post-treatment mean values of overall stability index for both the control and the study groups.

Item	Stability index (degrees) $\bar{X} \pm SD$	MD	Change (%)	T value	P value	Significance
Control group	5.087 ± 0.835					
Study group	4.36 ± 0.422	0.727	14.29%	3.0083	< 0.05	S

N.B: S = Significant.

Table 5 Pre-treatment mean values of antero-posterior stability index for both the control and the study groups.

Item	Patient's groups	$\bar{X} \pm SD$	MD	t Value	P Value	Significance
Antero-posterior	Control group	4.273 ± 0.819				
balance (Degrees)	Study group	3.96 ± 1.051	0.313	0.9109	> 0.05	NS

Table 6 Post-treatment mean values of antero-posterior stability index for both the control and the study groups.

Item	Antero-posterior balance (Degrees) $\bar{X} \pm SD$	MD	Change (%)	T Value	P Value	Significance
Control group	4.047 ± 0.79					
Study group	3.4 ± 899	0.647	15.98%	2.092	< 0.05	S

Table 7 Pre-treatment mean values of medio-lateral stability index for both the control and the study groups.

Item	Patient's groups	$\bar{X} \pm SD$	MD	t Value	P Value	Significance
Medio-lateral balance (degrees)	Control group	4.347 ± 0.582				
	Study group	4.273 ± 0.527	0.073	0.361	> 0.05	NS

Table 8 Post-treatment mean values of medio-lateral stability index for both the control and the study groups.

Item	Medio-lateral balance (degrees) $\bar{X} \pm SD$	MD	t Value	P Value	Significance
Control group	4.267 ± 0.561				
Study group	3.847 ± 0.453	0.42	2.254	< 0.05	S

3.5. Comparison between pre-treatment mean values of antero-posterior stability index for both the control and study the groups

The mean values ± SD were 4.273 ± 0.819 and 3.96 ± 1.051 degrees for both the control and the study groups respectively which indicated no significant difference ($P > 0.05$) Table 5.

3.6. Comparison between post-treatment mean values of antero-posterior stability index in both the control and the study groups

The mean values ± SD were 4.047 ± 0.79 and 3.4 ± 899 degrees for both the control and the study groups respectively which indicated significant difference in favor of the study group ($P < 0.05$) Table 6.

3.7. Comparison between pre-treatment mean values of medio-lateral stability index for both the control and the study groups

The mean values ± SD were 4.347 ± 582 and 4.273 ± 0.527 degrees for both the control and the study groups respectively which indicated no significant difference ($P > 0.05$) Table 7.

3.8. Comparison between post-treatment mean values of medio-lateral stability index in both the control and the study groups

The mean values ± SD of medio-lateral stability index for both the control and the study groups were 4.267 ± 0.561 and 3.847 ± 0.453 degrees respectively which was significant in favor of the study group ($p < 0.05$) Table 8.

4. Discussion

Approximately two thirds of children with CP will achieve some walking ability. However, their walking patterns differ from those of healthy children [18]. A foot orthosis is an in-shoe medical device which is designed to alter the magnitudes and temporal patterns of the reaction forces acting on the plantar aspect of the foot in order to allow more normal foot and lower extremity function and to decrease pathologic loading forces on the structural components of the foot and lower extremity during weight bearing activities, for the ambulatory child with CP. It has been suggested that rigid AFOs are capable of improving the efficiency of gait and preventing deformities [19]. A review by Morris [12] concluded that preventing plantar-flexion improved gait efficiency by improving stability in the stance phase.

The present study included spastic diplegic type of cerebral palsy, which constitutes a major classification among spastic types. This finding was reported by Pellegrino and Dormans [20] who stated that spastic diplegia accounts nearly about 25–35% of spastic CP children. The pre-treatment results of the dynamic balance test obtained from both groups (control & study respectively) regarding the measuring variables showed no significant difference. While the pre-treatment mean values of overall stability index, anteroposterior stability index, and mediolateral stability index of the dynamic balance test for both the control and the study groups, showed an increase in their values, which means that those children had balance problems. These results were consistent with those reported previously by Mark et al. [21], who indicated that higher stability index was due to poor standing stability. Also the pre-treatment mean values of this study are in accordance with the findings of Roncesvalles et al. [22], who stated that one of the contributing factors in stability of children with spastic diplegia is a poor ability to increase muscle response amplitude when balance threats increase in magnitude.

Butler and Darrah [23] have shown that children with CP have a reduced ability to adapt their postural control to changing task and environmental demands. These postural impairments affect the ability to respond to challenges to balance efficiently and effectively which result in increases in tonic stretch reflexes, muscle weakness, excessive coactivation of antagonist muscles and increased stiffness around joints. In patients with brain injury, the automatic postural response is often disrupted especially with CP which frequently contributes to impairments in standing balance, leading to difficulty in walking and increased risk of falling [24]. Physiotherapy aims, therefore, to improve balance and to reduce postural sway in these patients. A recent summary of systematic reviews which were published by Smidt et al. [25], concluded that exercise was beneficial for people with a range of chronic conditions such as cerebral palsy, peripheral neuropathy, and ankylosing spondylitis. In a previous study Michelle and Johanna [26] reported that therapeutic exercises have a great benefit for children with CP through improving muscle strength, cardiovascular function, and gross motor skill performance.

Our results indicated post treatment improvement in favor of the study group as regards post treatment mean values of all stability indices (SI). These results were consistent with those reported by Testerman and Griend [27] who emphasized that the larger the numerical value of the stability index the greater the degree of difficulty or instability in balancing the platform. In addition Dong-wook et al. [28], reported that the mean values for anteroposterior (AP) and mediolateral (ML) displacement were significantly higher in children with spastic CP.

White et al. [29], reported that AFOs are prescribed to minimize gait irregularities and improve several measures of ambulation. Also Romkes and Brunner [30] stated that AFOs can be used to improve the gait and standing balance of children with spastic CP, decreasing muscle tone and providing a stable wide base of support. Additionally, Pohl and mehrholz [31] reported that AFOs are highly recommended as a form of orthotic intervention to improve the gait of patients with neuromuscular diseases, such as stroke, cerebral palsy, or brain injury. The time needed to reach stable standing was shortened with the hinged AFO in children who were more than one standard deviation slower than non CP children with barefoot. This is attributed to the effect of the ankle–foot orthosis on keeping standing balance with improving both posture alignment and reactions [32]. In addition AFO enhances the functional abilities of most children with spastic diplegia [33]. Although the normalization of ankle kinematics and kinetics with AFO use, it did not significantly alter the dynamics of proximal lower-extremity joints as measured by gait analysis, the significant changes in postural reactions, gait parameters, gross and fine motor function and energy efficiency of gait, indicate that the enhancement of stability with AFO use can have global effects on functional mobility skills. Despite the trepidation about restricting ankle dorsiflexion, a significant percentage of children with spastic diplegia benefit from the constraint of ankle dorsiflexion achieved by the use of static AFO. The significant improvement observed in our study group may be due to the combination between the uses of the three side support ankle–foot orthosis in addition to the rehabilitation exercise program which is based on the neural developmental sequence. This combination leads to improvement of the child's ability to stand and walk in a nearly correct way. So, it allows better motor function, more postural control, increase self confidence and motivation. Yamamoyo et al. [34], reported that there is a great importance of using the AFO in addition to gait exercise training in the early stages of rehabilitation of children with CP.

Another study by Morris and Bartlett [35] reported that AFOs directly influence the alignment of the body segments. They can also influence hip and knee joint movements by manipulating the direction of the ground reaction force. Stabilizing the ankle and the foot therefore allows therapy to focus training on strengthening and encouraging better control over proximal joints. Other common training targets include encouraging better head control by providing trunk stability [36].

The common stance of children with spastic diplegia characterized by ankles plantar flexion and hip medial (internal) rotation and adduction considerably narrows the child's base of support (BOS). This narrowing of BOS, in turn, could accentuate the impact of external perturbations, as it becomes more difficult to maintain the center of gravity inside a narrow BOS [37]. Our study mentions that the use of the three side support ankle–foot orthosis provided a wider base of support that stabilized the child and minimized the displacement of center of gravity (COG) under each foot. Also it helped the child to decrease postural sway, which reflected a good balance control.

Eva and Mijna [38] reported that the size of the support-base, influence the child's possibility to control posture. Interestingly Greve et al. [39], reported that the breadth of the base of support is critical to stability. Older adults often adopt a wider base of support for this reason. Width of base of support is, therefore, used as a measure of balance. Additionally Woollacott and Shumway [7] reported that the efficiency of balance recovery can be improved in children with CP, indicated by both a reduction in the total center of pressure path used during balance recovery and in the time to restabilize balance after training.

To conclude: our results showed that, continued practice with the three side support ankle–foot orthosis for 6 months, enabled the children in the study group to gain more balance control and postural reactions. Provost et al. [40], reported that, improvements in performance occur as a result of practice with AFO which normalized ankle kinematics in stance, increased step/stride length, and decreased energy cost of walking. Functionally, all AFO configurations improved walking/running/jumping skills, upper extremity coordination, and fine motor speed/dexterity [41].

Finally, three side support AFO can be added as an additional modality to improve balance and postural reactions of diplegic children.

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