Research Article

The Effect of Visual Feedback on Static Standing Balance in Children with Spastic Diplegic Cerebral Palsy Compared to Normal Children under Altered Sensory Environment

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Abstract | The aim of this study was to investigate the effect of visual feedback on static standing balance in children with spastic diplegic cerebral palsy (CP) compared to normal children under altered sensory environment. Out of 30 participants in the study, 15 children were with spastic diplegic CP with mean age and body mass index of 7 ± 1.3 years and 14.70 ± 1.73 kg/m^2 respectively and 15 normal children with mean age and body mass index of 7.2 ± 1 years and 14.83 ± 1.57 kg/m^2. Children were instructed to stand with bare feet for 60 seconds on a 5-cm-thick piece of foam which was placed on a Kistler force plate with their Eyes Open (EO), Eyes Close (EC) and Mirror Visual Feedback (MVF). Results demonstrate that there were no significant differences in mean values of static stability parameters in EC condition between children with spastic diplegic CP and typically developed children (P>0.05). There were no significant differences in mean values of static stability parameters during EC and EO condition in typically developed children (P>0.05). Children with spastic diplegic CP experience the best static standing stability in EC condition. The standing stability of these children reduces as the cognitive load of the conditions intensifies in EO and MVF, respectively.

Editor | Mohammad Taghi Karimi, Department of Orthotics and Prosthetics, Faculty of Rehabilitation, Isfahan University of Medical Sciences, Isfahan, Iran.
Received | April 14, 2016; **Accepted** | May 14, 2016; **Published** | July 21, 2016
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Citation | Tahmasebi, A., P. Raji and M. Kamali. (2016). The effect of visual feedback on static standing balance in children with spastic diplegic cerebral palsy compared to normal children under altered sensory environment. *Health Rehabil.* 1(2): 35-44.
DOI | http://dx.doi.org/10.17582/journal.hr/2016.1.2.35.44
Keywords | Visual feedback, Static standing balance, Spastic diplegic cerebral palsy

Introduction

Cerebral palsy (CP) is a non-progressive neuromotor disability with early onset occurring in developing brain of the fetus or infant. CP is one of the most prevalent reasons of childhood disability and the average life-long costs of this disability is estimated to be 11.5 billion dollars during 2000 in the United States only (Oskoui et al., 2013). The prevalence rate of CP is 2 cases per 1000 live births in the United States (Oskoui et al., 2013) and 2.06 cases per 1000 live births in Iran (Dalvand et al., 2012). Individuals with CP can experience different cognitive, sensory and motor disabilities concurrently (Liao and Hwang, 2003; Shumway-Cook and Woollacott, 1995; Campbell et al., 2006). With regard to the topography of the CP, the resulted motor impairments are divided into diplegia, hemiplegia, quadriplegia, monoplegia and triplegia (Laisram et al., 1992; Erkin et al., 2008). Investigation of the static standing stability is usually done in diplegic CP (Liao et al., 1997; Ledebt et al., 2005; Ferrari et al., 2010).

Static standing stability is the ability to maintain and/or control the center of mass of the body in the base of support provided by legs during standing (Umphred et al., 2013; Westcott et al., 1997). Poor standing stability can restrict motor abilities of an individual resulting in the reduced environmental exploration and interaction with friends and family members (Liao and Hwang, 2003; Shumway-Cook and Woollacott, 1995; Lepage et al., 1998) leading to a reduced quality of life (Ramachandran and Altschuler, 2009). Static standing stability is usually measured using postural stability and/or the amount of time during which the balance can be maintained (Rha et al., 2010). Investigating the excursion and velocity of Center of Pressure (COP) in mediolateral and anteroposterior planes, calculated from ground reaction force, is one of the most common methods to measure postural stability (Winter, 2009; Winter et al., 1990; Collins and De Luca, 1993; Doyle et al., 2007; De Kegel et al., 2011; Lin et al., 2008; Duarte and Freitas, 2010; Turbanski and Schmidtbleicher, 2010).

One of the techniques used to both measure and improve postural control is giving visual feedback information to the patient so that he/she can observe his/her COP excursions. In this method, the individual stands on a force plate and the position of his/her COP is shown on a monitor so that he can narrow his/her COP excursions following verbal directions. This method enables the individual to concurrently see and reduce his/her COP excursions in mediolateral and anteroposterior planes and it is widely used in the rehabilitation process of individuals with standing stability problems (Nichols, 1997; Sackley and Lincoln, 1997; Van Peppen et al., 2006; Wu, 1997). However, using this visual feedback technique is expensive and it is not applicable in clinical settings. On the other hand, using mirror visual feedback as an available inexpensive tool has proved to reduce COP excursions in elderly population (Vaillant et al., 2004; Hlavackova et al., 2009). To date, no study has investigated the effect of mirror visual feedback on static standing stability parameters in children with CP.

The results of literature review yield a controversy with regard to the effect of visual input on static standing balance in children with spastic diplegic CP. However, some researchers believe that visual input has no effect on static standing balance in children with spastic diplegic CP (Cherng et al., 1999; Donker et al., 2008; Liao et al., 1997), Nobre et al. (2009) and Rose et al. (2002) believe that visual input has a significant effect on static standing balance in children with spastic diplegic CP. Moreover, Saxena et al. (2014) states that visual input affect static standing balance only in children with spastic diplegic CP compared to children with hemiplegic CP. Importantly, the role and the degree of involvement of somatosensory inputs (including proprioception) in postural control is still a controversial matter (Simoneau et al., 1995).

Moreover, it has been suggested to use combining tasks requiring balance and usage of visual input such as mirror visual feedback to improve static standing balance (Saavedra et al., 2014). However, there is evidence showing that using mirror visual feedback can activate the mirror neurons system, which may adversely affect static standing balance (Nejati et al., 2013). With regard to the higher prevalence rate of gravitational insecurity among children with spastic diplegic CP (Case-Smith and O'Brien, 2014) and its effect on static stability, the aim of this study was to investigate the effect of visual feedback on static standing balance in children with spastic diplegic CP compared to normal children under altered sensory environment.

Methods and Materials

Thirty participants including 15 children with spastic diplegic CP and 15 typically developed children were selected conveniently for the study. The inclusion criteria were as follow: **a)** to be aged between 5 to 8 years old, **b)** not to use orthosis for walking, **c)** not to be afflicted with cardiovascular disease, **d)** not performing surgical operation 6 months prior to the initiation of the study, **e)** not having visual nor auditory impairments, **f)** not to be afflicted with epilepsy, **g)** not taking medicines affecting static standing stability, **h)** the ability to stand independently for 60 seconds, **j)** to be classified as level 2 or 3 on the Gross Motor Function Classification Scale and **k)** the ability to understand and follow verbal commands. Reluctance to continue participation in the study was considered as an exclusion criterion. It is important to note that children with spastic diplegic CP and typically developed children were matched based on age and body mass index.

The study was approved by the Ethics Committee for

Human Experiments, Tehran University of Medical Sciences. An informed consent was obtained from the parents of children. Moreover, children stated their tendency to participate in the study and a small toy was given to them to thank their participation.

The children were instructed and demonstrated on how to perform the tests. Static stability was tested under 3 conditions: Eyes Open on Foam (EOF), Eyes Close on Foam (ECF) and Mirror Visual Feedback on Foam (MVFF). Children were instructed to stand for 60 seconds on a 5-cm-thick piece of foam which was placed on a force plate. In the MVFF condition, the mirror was placed in front of the children in a 1-meter distance (Hlavackova et al., 2009). Under the EOF condition, Children were instructed to look at a fixed point in a 1 meter distance in front of them. Children were demonstrated to stand on the force plate with bare feet, with their arms at their sides and their feet at shoulder width. Each condition was tested 3 times and the mean values were utilized for the final data analysis.

A Kistler force plate (Kistler Model 9285 Quartz Force, USA) was used to measure COP excursions. The following parameters were utilized to measure static stability during quite standing.

COP path length in mediolateral plane, COP path length in anteroposterior plane, COP excursion in mediolateral plane, COP excursion in anteroposterior plane, COP velocity in mediolateral plane and COP velocity in anteroposterior plane.

Normal distribution of the static standing stability parameters were calculated using Kolmogorov-Smirnov test. Descriptive statistics were utilized to describe demographic information of the participants. Independent t-test was used to compare mean values of static standing stability parameters between children with spastic diplegic CP and typically developed children. Paired t-test was used to compare each two of the three conditions (EOF and ECF, EOF and MVFF, ECF and MVFF) in children with spastic diplegic CP and typically developed children. Statistical

Table 1: *Comparing mean values of static stability parameters (COP path length in ML, COP path length in AP, COP excursion in ML, COP excursion in AP, COP velocity in ML and COP velocity in AP) in children with cerebral palsy and typically developed children during ECF, EOF and MVFF conditions*

Conditions	Static Stability Parameters	Typically Developed Children (Mean ± SD[6])	Children with Cerebral Palsy (Mean ± SD)	Independent t-value	P-value
ECF[1]	COP path length in ML[4] (mm)	4353.60±1791.99	3794.76±1598.86	-.90	.375
	COP path length in AP[5] (mm)	5679.92±2407.40	5231.85±2353.53	-.52	.610
	COP excursion in ML (mm)	52.20±17.58	63.26±12.52	1.98	.057
	COP excursion in AP (mm)	53.88±25.68	66.07±18.89	1.48	.150
	COP velocity in ML (mm/min)	8707.20±3583.98	7726.90±3245.27	-.79	.439
	COP velocity in AP (mm/min)	11359.83±4814.80	10617.59±4930.60	-.42	.680
EOF[2]	COP path length in ML (mm)	3486.83±913.86	3675.78±1486.92	.42	.679
	COP path length in AP (mm)	4772.89±1423.64	5128.55±2367.86	.50	.623
	COP excursion in ML (mm)	45.12±7.25	73.89±24.25	4.40	.001***
	COP excursion in AP (mm)	45.84±12.46	96.42±37.85	4.92	.001***
	COP velocity in ML (mm/min)	6706.99±1491.07	7211.54±3200.91	.55	.586
	COP velocity in AP (mm/min)	9252.44±2127.88	9856.37±3498.43	.57	.573
MVFF[3]	COP path length in ML (mm)	3566.10±1095.73	4448.73±2012.16	1.49	.150
	COP path length in AP (mm)	4823.10±1419.46	6084.26±2550.89	1.67	.109
	COP excursion in ML (mm)	46.01±11.31	66.32±17.58	3.76	.001***
	COP excursion in AP (mm)	48.45±16.94	78.05±28.17	3.48	.002**
	COP velocity in ML (mm/min)	6998.87±1940.69	8893.35±3547.68	1.81	.083
	COP velocity in AP (mm/min)	8946.21±2255.38	10743.29±3860.10	1.55	.133

*** P≤.01; *** P≤.001; [1] Eyes Close on Foam; [2] Eyes Open on Foam; [3] Mirror Visual Feedback on Foam; [4] Mediolateral Plane; [5] Anteroposterior Plane; [6] Standard Deviation*

Package for Social Sciences (SPSS) version 22 was utilized for data analysis.

Results

Fifteen children (6 girls and 9 boys) with spastic diplegic CP with mean age and body mass index of 7 ± 1.3 years and 14.70 ± 1.73 kg/m^2 respectively and 15 typically developed children (6 girls and 9 boys) with mean age and body mass index of 7.2 ± 1 years and 14.83 ± 1.57 kg/m^2 participated in this study. Two groups were matched based on age and body mass index.

As shown in Table 1, there were no significant differences in mean values of static stability parameters in ECF condition between children with spastic diplegic CP and typically developed children ($P>0.05$). However, significant differences were reported in mean values of COP excursion in mediolateral and anteroposterior planes in EOF and MVFF condition

Table 2: *Comparing mean values of static stability parameters (COP path length in ML, COP path length in AP, COP excursion in ML, COP excursion in AP, COP velocity in ML and COP velocity in AP) during ECF and MVFF condition in children with cerebral palsy and typically developed children*

Groups	Static Stability Parameters	ECF[1] (Mean ± SD[3])	MVFF[2] (Mean ± SD)	Paired t-value	P-value
Children With Cerebral Palsy	COP path length in ML[4] (mm)	3794.77±1598.86	4448.73±2012.16	-2.14	.050*
	COP path length in AP[5] (mm)	5231.85±2353.53	6084.26±2550.89	-3.29	.005**
	COP excursion in ML (mm)	63.26±12.51	66.32±17.58	-.75	.467
	COP excursion in AP (mm)	66.07±18.89	78.05±28.17	-1.61	.128
	COP velocity in ML (mm/min)	7726.90±3245.27	8893.35±3547.68	-1.75	.100
	COP velocity in AP (mm/min)	10617.59±4930.60	10743.29±3860.10	-.17	.868
Typically Developed Children	COP path length in ML (mm)	4353.60±1791.99	3566.10±1095.73	1.67	.117
	COP path length in AP (mm)	5679.91±2407.40	4823.10±1419.46	1.60	.132
	COP excursion in ML (mm)	52.18±17.58	46.01±11.31	1.26	.227
	COP excursion in AP (mm)	53.87±25.68	48.45±16.94	1.11	.285
	COP velocity in ML (mm/min)	8707.20±3583.98	6998.87±1940.69	1.85	.086
	COP velocity in AP (mm/min)	11359.83±4814.80	8946.20±2255.38	2.50	.025*

** P≤.05; ** P≤.01; [1] Eyes Close on Foam; [2] Mirror Visual Feedback on Foam; [3] Standard Deviation; [4] Mediolateral Plane; [5] Anteroposterior Plane*

Table 3: *Comparing mean values of static stability parameters (COP path length in ML, COP path length in AP, COP excursion in ML, COP excursion in AP, COP velocity in ML and COP velocity in AP) during ECF and EOF condition in children with cerebral palsy and typically developed children*

Groups	Static Stability Parameters	ECF[1] (Mean ± SD[3])	EOF[2] (Mean ± SD)	Paired t-value	P-value
Children With Cerebral Palsy	COP path length in ML[4] (mm)	3794.77±1598.86	3675.78±1486.92	.62	.545
	COP path length in AP[5] (mm)	5231.85±2353.53	5128.55±2367.86	.30	.768
	COP excursion in ML (mm)	63.26±12.51	73.82±24.24	-1.82	.090
	COP excursion in AP (mm)	66.07±18.89	96.42±37.85	-4.17	.001***
	COP velocity in ML (mm/min)	7726.90±3245.27	7211.54±3200.91	1.13	.279
	COP velocity in AP (mm/min)	10617.59±4930.60	9856.37±3498.43	.93	.370
Typically Developed Children	COP path length in ML (mm)	4353.60±1791.99	3486.83±913.86	1.87	.083
	COP path length in AP (mm)	5679.91±2407.40	4772.89±1423.64	1.59	.135
	COP excursion in ML (mm)	52.18±17.58	45.12±7.25	1.71	.109
	COP excursion in AP (mm)	53.87±25.68	45.84±12.46	1.90	.078
	COP velocity in ML (mm/min)	8707.20±3583.98	6706.99±1491.07	2.01	.086
	COP velocity in AP (mm/min)	11359.83±4814.80	9252.43±2127.88	1.74	.025

**** P≤.001; [1] Eyes Close on Foam; [2] Mirror Visual Feedback on Foam; [3] Standard Deviation; [4] Mediolateral Plane; [5] Anteroposterior Plane* between children with spastic diplegic CP and typically developed children ($P \le 0.05$).

Table 2 compares mean values of static stability parameters between ECF and MVFF condition in children with cerebral palsy and typically developed children. COP path length in mediolateral and anteroposterior planes showed a significant difference between ECF and MVFF condition in children with cerebral palsy ($P \le 0.05$). COP velocity in anteroposterior plane showed a significant difference between ECF and MVFF condition in typically developed children ($P \le 0.05$).

Table 3 depicts that there were no significant differences in mean values of static stability parameters during ECF and EOF condition in typically developed children ($P > 0.05$). However, a significant difference was reported in mean value of COP excursion in anteroposterior plane during ECF and EOF condition in children with spastic diplegic CP ($P \le 0.05$).

Table 4 compares mean values of static stability parameters during EOF and MVFF condition in children with cerebral palsy and typically developed children. There were no significant differences in mean values of static stability parameters during EOF and MVFF condition in typically developed children ($P > 0.05$). However, significant differences were reported in mean values of COP path length in mediolateral and anteroposterior planes, COP excursion in anteroposterior plane and COP velocity in mediolateral plane during EOF and MVFF condition in children with spastic diplegic CP ($P \le 0.05$).

Discussion

Static standing stability is the ability to maintain and/or control the center of mass of the body in the base of support provided by legs during standing (Umphred et al., 2013, Westcott et al., 1997). Poor standing stability can restrict motor abilities of an individual resulting in the reduced environmental exploration leading to a reduced quality of life (Ramachandran and Altschuler, 2009). The results of literature review yield a controversy with regard to the effect of visual nput on static standing balance in children with spastic diplegic CP. Importantly, the role and the degree of involvement of somatosensory inputs (including proprioception) in postural control is still a controversial matter (Simoneau et al., 1995). Moreover, it has been suggested to use combining tasks such as mirror visual feedback to improve static standing balance (Saavedra et al., 2014). However, there is evidence showing that using mirror visual feedback may adversely affect static standing balance (Nejati et al., 2013). Therefore, the aim of this study was to investigate the effect of visual feedback on static standing balance in children with spastic diplegic CP compared to normal children under altered sensory environment.

As shown in Table 1, all mean values of static stability

Table 4: *Comparing mean values of static stability parameters (COP path length in ML, COP path length in AP, COP excursion in ML, COP excursion in AP, COP velocity in ML and COP velocity in AP) during EOF and MVFF condition in children with cerebral palsy and typically developed children*

Groups	Static Stability Parameters	EOF[1] (Mean ± SD[3])	MVFF[2] (Mean ± SD)	Paired t-value	P-value
Children With Cerebral Palsy	COP path length in ML[4] (mm)	3675.78±1486.92	4448.73±2012.16	2.52	.025*
	COP path length in AP[5] (mm)	5128.55±2367.86	6084.26±2550.89	2.85	.013*
	COP excursion in ML (mm)	73.82±24.24	66.32±17.58	-1.44	.171
	COP excursion in AP (mm)	96.42±37.85	78.05±28.17	-2.78	.015*
	COP velocity in ML (mm/min)	7211.54±3200.91	8893.35±3547.68	3.06	.008**
	COP velocity in AP (mm/min)	9856.37±3498.43	10743.29±3860.10	1.67	.118
Typically Developed Children	COP path length in ML (mm)	3486.83±913.86	3566.10±1095.73	.61	.552
	COP path length in AP (mm)	4772.89±1423.64	4823.10±1419.46	.30	.767
	COP excursion in ML (mm)	45.12±7.25	46.01±11.31	.29	.772
	COP excursion in AP (mm)	45.84±12.46	48.45±16.94	.72	.486
	COP velocity in ML (mm/min)	6706.99±1491.07	6998.87±1940.69	1.05	.313
	COP velocity in AP (mm/min)	9252.43±2127.88	8946.20±2255.38	-.78	.450

** P≤.05; ** P≤.01; [1] Eyes Close on Foam; [2] Mirror Visual Feedback on Foam; [3] Standard Deviation; [4] Mediolateral Plane; [5] Anteroposterior Plane* parameters during EOF and MVFF condition are higher in children with spastic diplegic CP comparedto typicall developed children. That is, children with spastic diplegic CP experience a worse static standing stability during EOF and MVFF condition compared to typically developed children that is in consistent with the result obtained by similar studies (Liao et al., 1997; Cherng et al., 1999; Donker et al., 2008; Nobre et al., 2009). However, in ECF condition there was no significant difference between children with spastic diplegic CP and typically developed children with regard to static stability parameters that is in contrast with the results obtained by Saxena (Saxena et al., 2014). Perhaps, the differences in mean values of age and body mass index of the participants, thickness of the used foam, using orthosis for standing by children with spastic diplegic CP (Saxena et al., 2014) may be responsible for such differences in the results.

As shown in the Table 2, all mean values of static stability parameters during ECF condition are lower compared to MVFF condition in children with spastic diplegic CP. That is, children with spastic diplegic CP experience a better static standing stability during ECF condition compared to MVFF condition. However, all mean values of static stability parameters during ECF condition are higher compared to MVFF condition in typically developed children. That is, typically developed children experience a better static standing stability during MVFF condition compared to ECF condition.

Although mean value of COP excursion in anteroposterior plane is significantly lower in ECF condition compared to EOP condition in children with spastic diplegic CP, with reference to the literature on the importance and contribution of each parameter in predicting static standing stability no definitive comment upon the answer to the effect of vision on standing stability under altered sensory environment in children with spastic diplegic CP may be made. The mean value of difference between ECF condition and EOP condition was 515.36 mm/min and 761.22 mm/min with regard to COP velocity in mediolateral and anteroposterior planes, respectively, in children with spastic diplegic CP. According to the literature COP velocity in mediolateral and anteroposterior planes have the most importance and contribution in predicting static standing stability (Doyle et al., 2005). The biomechanical interpretation of the results in comparing ECF condition and EOP condition is that children with spastic diplegic CP in ECF condition experience COP excursion in a narrower amplitude compared to EOP condition; however, the COP velocity especially in anteroposterior plane is higher in ECF condition compared to EOP condition which is consistent with the results obtained by similar studies (Cherng et al., 1999; Donker et al., 2008; Liao et al., 1997).

As depicted in Table 4, most of the mean values of static stability parameters, especially COP velocity in mediolateral and anteroposterior planes, during EOF condition are lower compared to MVFF condition in children with spastic diplegic CP. That is, children with spastic diplegic CP experience a better static standing stability during EOF condition compared to MVFF condition. However, there were no significant differences in mean values of static stability parameters during EOF condition and MVFF condition in typically developed children.

Collectively, the results of Table 2, 3 and 4 show that children with spastic diplegic CP experience the worst static standing stability in MVFF condition and the best static standing stability in ECF condition. Moreover, most of the mean values of static stability parameters in EOF condition place in the middle of this range, from the worst standing stability experience to the best standing stability experience. However, in typically developed children the worst static standing stability experience was in ECF condition and the best static standing stability experience was in EOF and MVFF condition.

It has been said that children with CP have an increased dependence on somatosensory inputs. These inputs are from joint receptors, muscle spindles and cutaneous receptors (Shumway-Cook and Woollacott, 2007) which are possible to be affected by musculoskeletal impairments that are common in children with CP (Saxena et al., 2014). Therefore, these structural impairments result in an altered sensory processing and organizing pattern affecting the ability to integrate multiple inputs from different resources, as a cognitive task, to adapt a proper stability (Bar-Haim et al., 2013). From this point of view, it can be said that children with spastic diplegic CP had the best static standing stability in ECF condition because this condition had the lowest load of integrating multiple sensory inputs from different organs compared to EOF and MVFF condition. Similarly, as the cognitive requirements of the task intensify, the children will experience a worse (EOF condition) and the worst (MVFF condition) static standing stability. However, typically developed children with an intact integrating multiple inputs process had the worst static standing stability experience in ECF condition, because the useful visual input had been eliminated, and the best static standing stability experience in EOF and MVFF condition with no difference between EOF and MVFF condition.

According to the results, using mirror visual feedback had the worst effect on standing stability of children with spastic diplegic CP. Therefore, the suggestion of Saavendra et al (Saavedra et al., 2014) about using combining tasks requiring balance and usage of visual input such as mirror visual feedback cannot improve static standing stability of children with spastic diplegic CP. However, according to Nejati et al. (2013) activation of the mirror neurons system, especially when using mirror visual feedback, may adversely affect static standing balance. With regard to the hypothesis of Nijati et al. (2013) and the similarity of results between children with spastic diplegic CP and typically developed children during MVFF condition, it can be posited that the child experience a worse standing stability during MVFF condition because watching his/her instability in the mirror can adversely affect the static stability. Therefore, the child scrambles to correct his/her instability leading to a more instability. From another point of view, children with neurological conditions such as CP need to hire compensating strategies to compensate for their musculoskeletal impairments so that they can experience a better standing stability. This extra cognitive task may be the reason because of which the children with CP have difficulty in dealing with environmental distractions or external cognitive loads such as combining tasks which reduce stability in children with CP (Reilly et al., 2008).

There are some key limitations and useful suggestions which should be acknowledged regarding this study. First, there is at present no actual measure of "standing stability", merely inferences based on quantitative parameters such as maximum COP excursion, COP velocity, etc. None of these parameters have been shown to be solely indicative of the quality of standing balance, though they are certainly related. At present, clinical quantitative measures such as the "equilibrium score" obtained through use of a Neurocom balance testing system use a composite of several parameters for assessment. Alternatively, performance-based metrics are used such as the Berg Balance Scale (Downs et al., 2013). Each such method has its limitations. Second, the use of quiet standing with eyes open and eyes close as a test of standing stability is the best-case scenario for investigating visual input and standing stability. However, it imposes limitations to detect a significant and reliable difference in standing stability between children with spastic diplegic CP and typically developed children. If, due to increased use of compensatory strategies, children with spastic diplegic CP need to use more cognitive resources to achieve standing balance performance, then distractions or other external cognitive loads (other than MVFF condition) such as doing a mentally demanding quiz for example should degrade their stability performance more than typically developed children. Future study designs should take these concepts into consideration.

Conclusions

According to the results of this study, children with spastic diplegic CP experience the best static standing stability in ECF condition. The standing stability of these children reduces as the cognitive load of the conditions intensifies in EOF and MVFF, respectively. Using mirror visual feedback worsens the standing stability of both typical children and children with CP and it cannot be used to improve static standing stability of children with spastic diplegic CP.

Acknowledgments

This study was funded by the Tehran University of Medical Sciences Research Committee with a reference number of 94-04-32-30935. The authors would like to pay their special thanks to parents and children who participated in this study.

Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this article.

Authors' Contribution

Study concept and design was prepared by all the authors. Analysis and interpretation of data was done by Ali Tahmasebi. Ali Tahmasebi and Parvin Raji drafting of the manuscript. Mostafa Kamali critically revised the manuscript for important intellectual content.

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