International Journal of Psychosocial Rehabilitation, Vol. 24, Issue 08, 2020
ISSN: 1475-7192

Efficacy of Lower Extremity Mirror Therapy on Balance in Children With Hemiplegic Cerebral Palsy: A Randomized Controlled Trial

[1]Nehad A. Abo-zaid, [2]Hebatallah M.Zaghloul, [3]Heba A. Khalifa., [4]Mohammed E. Ali, [5]Mohammed Y. Abdelsamee

Abstract—

Aim: *To assess the efficacy of lower extremity mirror therapy on balance in children with hemiplegic cerebral palsy.*

Methodology: *Sixty hemiplegic cerebral palsy children were selected in this study after the assessment of eligibility. Their ages ranged from eight to twelve years. They were randomly assigned into two equal groups. The control group (GA) received a guideline protocol. And study group (GB) received the same guideline protocol in addition to mirror therapy three times / weak for three successive months. Assessment of balance by Biodex balance system pre and post-treatment that continued three months.*

Results: *Post-treatment, significant improvement was in the Overall stability index, the Anteroposterior stability index, and the Mediolateral stability index in both groups and in favor of (GB) (P< 0.05).*

Conclusions: *Lower extremity mirror therapy has a significant effect on balance in children with hemiplegic cerebral palsy.*

Key words*--Hemiplegic cerebral palsy, Balance, Mirror therapy.*

I. INTRODUCTION

Cerebral Palsy (CP) is a group of motor disorders resulting from damage to the brain of the child, affects the motor system, and leads to poor balance, poor coordination, or abnormality in patterns of movement [**1**]. The most common type of CP is hemiplegic CP that affecting one person per thousands of live births, characterized by a clinical pattern of unilateral motor impairment, movement disabilities, and postural disturbance [**2**], which contributes to their gait abnormalities [**3**]. All balance parameters affected in hemiplegic CP due to musculoskeletal asymmetry show significant differences than those of typically developing children [**4**]. The control of balance has great importance in most functional skills performance, aiding the child`s recovery from unexpected disturbances in balance, either caused by slips and trips or due to self-induced

[1]*Lecturer of physical therapy, Department of Physical Therapy for Pediatrics, Faculty of Physical Therapy, South Valley University, Qena, Egypt. E-mail: dr.nehadahmed@svu.edu.eg*
[2]*Lecturer of physical therapy, Department of Orthopedic, Cairo University Hospitals, Cairo University, Egypt.*
[3]*Lecturer of physical therapy, Department of Physical Therapy for neuromuscular disorders and its surgery, Faculty of Physical Therapy, Cairo University, Cairo, Egypt. E-mail: Dr_hobi@yahoo.com.*
[4]*Assistant Lecturer of physical therapy, Department of Physical Therapy for Integumentary System Disorders and Burn, Faculty of Physical Therapy, South Valley University, Qena, Egypt. E-mail: m.essam@svu.edu.eg.*
[5]*Lecturer of physical therapy, Department of Basic Science, Faculty of Physical Therapy, Delta University for Science and Technology, Egypt. E-mail: dr_m_yahya@yahoo.com.*

Received: 27 Mar 2020 | Revised: 20 Apr 2020 | Accepted: 05 May 2020

instability during movement [**5**]. Abnormal postural control in hemiplegic cerebral palsied children has a negative effect on balance capacity. They have insufficient static and dynamic balance reactions when compared with their peers with normal development [**6**].

Mirror therapy (MT) is a simple, effective, and low-cost technique used to improve the mobility of affected limbs by visual feedback induced by the non-affected limb movement in the mirror [**7**]. MT explained by three main mechanisms 1) it facilitates locomotion recovery by visual feedback of the normal side movement that reflects stimulation of movement in the affected side [**8**]. 2) Activation of mirror neurons that facilitate movements of the affected limb [**9**]. 3) Simultaneous motion of normal and affected limbs that stimulate the affected cerebral cortex by interactions with the stimulation of non-affected cerebral cortex [**10**].

Numerous studies showed the significant effect of MT on the rehabilitation of upper extremity but very limited studies investigated the effect of MT in the rehabilitation of lower extremity in adults. It was found that MT combined with strengthing muscles of lower extremity had a positive effect on gait in stroke patients [**11**], also MT enhanced motor functioning and motor recovery of lower-extremity in stroke patients [**12**]. Up till now, there are no studies investigated the effect of MT in the rehabilitation of lower-extremity in children. So we suggest that mirror therapy may add value in the rehabilitation of the lower extremity, so our study aimed to assess the efficacy of lower extremity MT on balance in hemiplegic cerebral palsy children.

II. METHODOLOGY

This randomized controlled study was conducted in the outpatient clinic in the Faculty of Physical Therapy, Cairo University. Informed consent was submitted by the parents of each child. Our procedures had No: P.T.REC/012/002575 that approved by the Institutional Ethical Committee Clearance of the Faculty of Physical Therapy at Cairo University. The registration number of our study was: NCT04227262 that was registered on Clinicaltrial.gov.

Study population

Children who were diagnosed as having hemiplegic CP based on careful clinical assessment by a physiotherapist. After screening, the selected children were from both sex, their ages ranged from eight to twelve years, they were from both sexes, they had mild to moderate spasticity according to the Modified Ashworth Scale, they were stable medically and psychologically, they were able to follow verbal commands or instructions. We excluded from the study children who had any visual or auditory problems, children that had a history of epilepsy, children with a history of any surgical interference in lower limbs for less than one year, children with unstable medical status especially those with cardiovascular disorders, mentally retardation, and un-cooperative children.

Randomization

Seventy children with hemiplegic CP were evaluated for eligibility. Three children did not meet the criteria of our selection and three refused to enroll. Sixty-four children were assigned randomly into two groups

International Journal of Psychosocial Rehabilitation, Vol. 24, Issue 08, 2020
ISSN: 1475-7192

of equal numbers. Random allocation software was used to minimize selection bias [**13**]. A diagram of children's retention and randomization throughout the study is shown in fig (1).

Flow chart

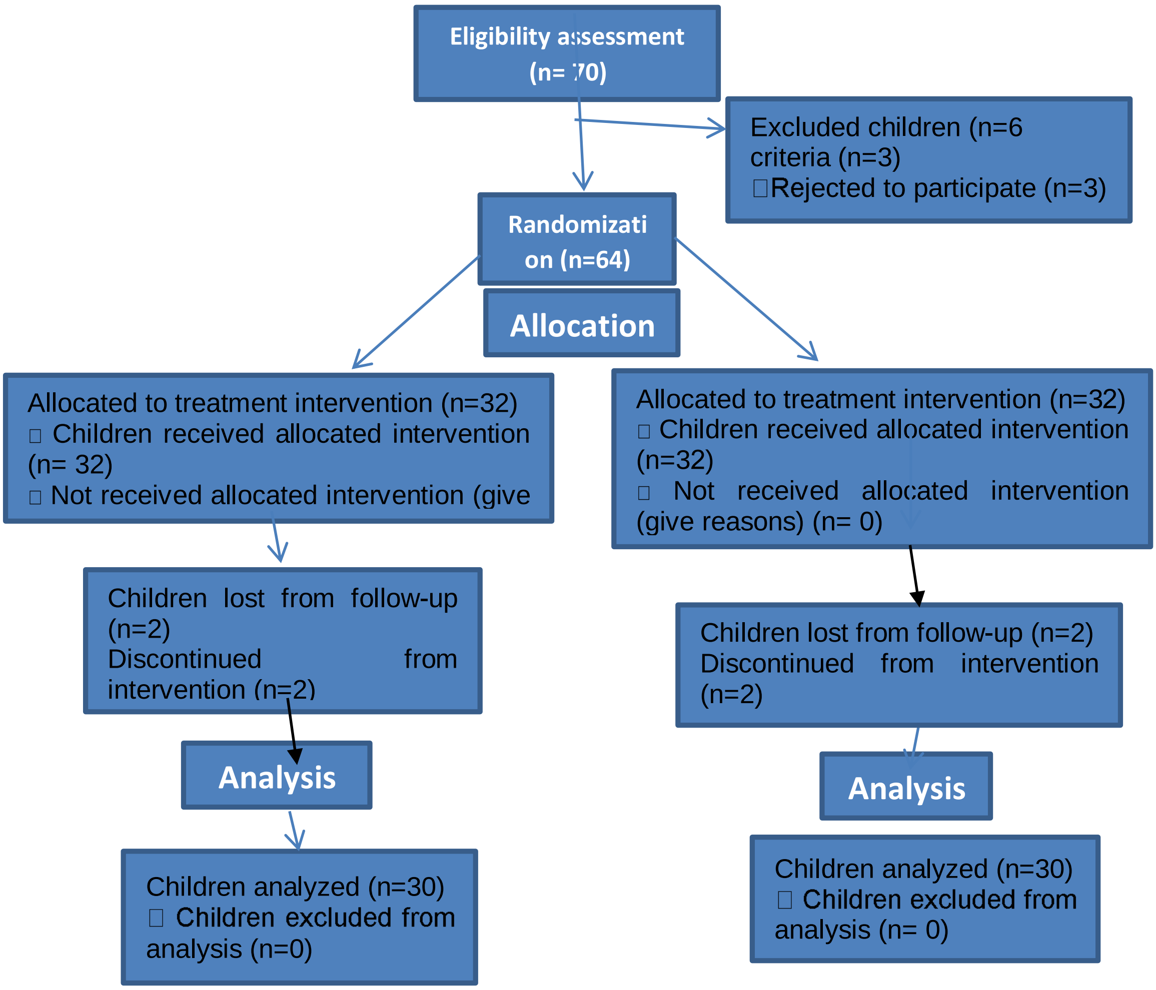

Fig 1 Flow chart

The control group (GA) received a guideline protocol. And study group (GB) received the same guideline protocol in addition to MT three times / weak for three successive months. All children were evaluated using the Biodex balance system before and after three months of intervention.

Materials for evaluation

The Biodex Balance System (BBS) is an important therapeutic tool used for the assessment and training of patients with deficits in balance [**14**]. The Biodex balance system is a reliable and valid device that used to evaluate the child`s ability to maintain static and dynamic balance stability on the unstable tilting platform; clinicians could evaluate postural control by measuring the ability to maintain dynamic unilateral and bilateral posture stability on the unstable surface. During the posture stability test, we evaluate the variance from the center by measuring the ability of the participant to control the platform's angle of tilt [1**5, 16**]. A dynamic balance test was performed on stability level six according to a prior pilot study. The outcome measures were: Over All Stability Index (OASI) that refers to the ability of child to maintain his balance in all directions, Antero-Posterior Stability Index (APSI) that refers to the child`s ability to maintain his balance from forward to backward direction and Medio-Lateral Stability Index (MLSI) that refers to the child`s ability to maintain his balance from side to side directions. High values indicate that the child had difficulty.

Methods of Treatment

The control group (GA) received 60 minutes of a guideline protocol that was based on neurodevelopment basis that was included; standing on one foot, stride standing allowing weight shift from one limb to another, standing on balance board, stoop and recovery from standing position, balancing exercises from standing in the form of equilibrium, righting and protective reactions training, improving trunk control, balance training exercises, gait training exercises in an open environment and stretching exercises for elbow extensors and forearm supinator of upper limbs, hip flexors, and adductors, hamstrings and calf muscles of lower limbs [17]. And study group (GB) received 30 minutes of the same guideline protocol in addition to 30 minutes MT three times / weak for three consecutive months. The children were instructed to standing /sitting on a chair and in the child`s mid-sagittal plane, the mirror was placed, with the normal limb placed in front of the mirror and the affected limb was blocked so the child sees only the reflected movement of the sound limb (non-affected); the children were asked to make repetitive movements of ankle dorsiflexion, knee extension from sitting, hip flexion and abduction from standing; the movement of paralyzed limbs through the reflection in the mirror shows a visual illusion of normal movement.

Statistical analysis

SPSS Package program version 25 for Windows (SPSS, Inc., Chicago, IL)., Data was screened prior to the final analysis for normality assumption test by using the Shapiro-Wilk test (P>0.05). Independent t-test was used to compare two groups for age, weight, height, and BMI variables, also the Chi-square test to compare between 2 groups for gender variable. Multivariate Analysis of Variance (MANOVA; 2 x 2 mixed design) was used to compare the tested variables of interest at different tested groups and measuring periods. All statistical analyses were significant when ($P \leq 0.05$).

III. RESULTS

A total of 60 patients participated in this study, they were distributed randomly into 2 groups of equal numbers. Before treatment, there were no significant differences in age (P=0.290), weight (P=0.149), height (P=0.180), BMI (P=0.665), and gender (P=0.371) between two groups (Table 1 and Figure 2).

Multivariate tests by MANOVA for outcome measures (Table 2) presented a statistically significant (P<0.05) effects due to main effects of tested groups (F= 10.803;P= 0.0001; Partial η^2= 0.252), measuring time

(F= 66.689;P= 0.0001; Partial η^2= 0.637), and group x time interaction (F= 3.138;P= 0.028; Partial η^2= 0.076). The statistical analysis within each group revealed there were significantly decreased (P<0.05) in post-treatment of OASI (Table 3and Figure 3), APSI (Table 3 and Figure 4), and MLSI (Table 3 and Figure 5) when compared to pre-treatment within control group (P=0.0001, P=0.0001, and P=0.001, respectively) and study group (P=0.0001, P=0.0001, and P=0.0001, respectively). Study group had improved higher than control group for OASI (24.81 vs. 19.68%, respectively), APSI (23.30 vs. 14.48%, respectively), and MLSI (35.89 and 20.00%, respectively).

There were no significant differences (P>0.05) in mean values before-treatment (Table 3) of OASI (P=0.054), APSI (P=0.309), and MLSI (P=0.935) between both groups. However, there were significant differences in the mean values after treatment (Table 3) of OASI (P=0.0001), APSI (P=0.002), and MLSI (P=0.022) between both groups.

Table 1: Comparison mean values of demographic data between two groups.

Variables	**Control group (n=30)**	**Study group (n=30)**	**test-value**	**P-value**
Age (Year)	9.67±1.5	9.27±1.4	1.066	0.290
Weight (kg)	28.67±3.93	27.10 ±4.36	1.463	0.149
Height (cm)	117.6±8.41	114.8±7.8	1.356	0.180
BMI (kg/m^2)	20.73 ±2.83	20.56 ±2.36	0.435	0.665
Gender (Male : Female)	21 (70%) : 9 (30%)	24 (80%) : 6 (20%)	0.800	0.371

Data are expressed as mean ± standard deviation (SD) or by number (%) and P-value>0.05: non-significant

Table 2: Main effects of independent variables by MANOVA test for all dependent measuring variables.

Source of variation	**Wilk's Lambada Value**	**Partial Eta^2 (η2)**	**F-value**	**P-value**
Tested groups effect	0.779	0.221	10.803	0.0001*
Measuring period effect	0.363	0.637	66.689	0.0001*
Interaction effect	0.924	0.076	3.138	0.028*

P-value: probability value * Significant (P-value <0.05)

Table 3: The 2 x 2 mixed design MANOVA for all dependent measuring variables within and between two groups.

Variables		**Groups (Mean ±SD)**		**F-value**	***P*-value**
		Control	**Study**		

		group (n=30)	**group (n=30)**		
OASI	Pre-treatment	3.71±0.60	3.45±0.42	3.877	0.054
	Post-treatment	2.98±0.64	2.47±0.40	13.672	0.0001*
	Change	0.73	0.98		
	Improvement %	19.68%	28.41%		
	F-value	20.795	84.829		
	P-value	0.0001*	0.0001*		
APSI	Pre-treatment	2.90±0.40	2.79±0.29	1.054	0.309
	Post-treatment	2.48±0.44	2.14±0.37	10.798	0.002*
	Change	0.42	0.65		
	Improvement %	14.48%	23.30%		
	F-value	14.020	58.359		
	P-value	0.0001*	0.0001*		
MLSI	Pre-treatment	2.10±0.48	2.09±0.47	0.007	0.935
	Post-treatment	1.68±0.48	1.34±0.62	5.508	0.022*
	Change	0.42	0.75		
	Improvement %	20.00%	35.89%		
	F-value	11.707	27.881		
	P-value	0.001*	0.0001*		

SD: standard deviation P-value: probability value *Significant (P-value <0.05)

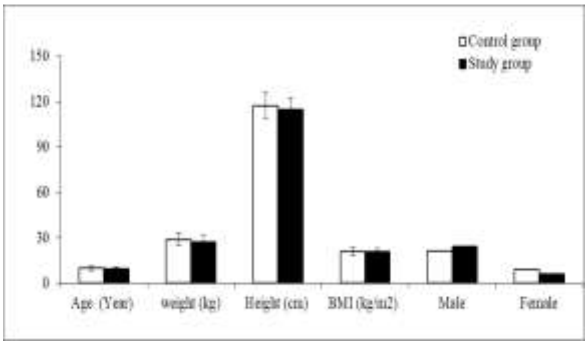

Figure 2: Values of demographic data in both groups.

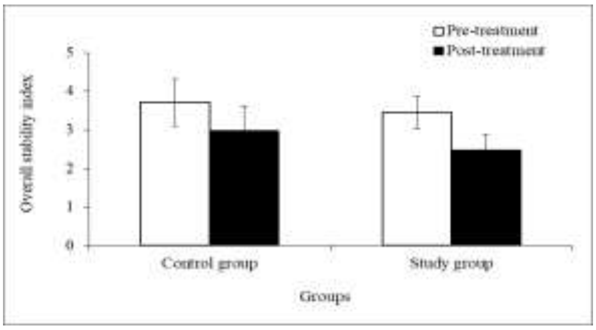

Figure 3: Mean values of before and after treatment OASI in both groups

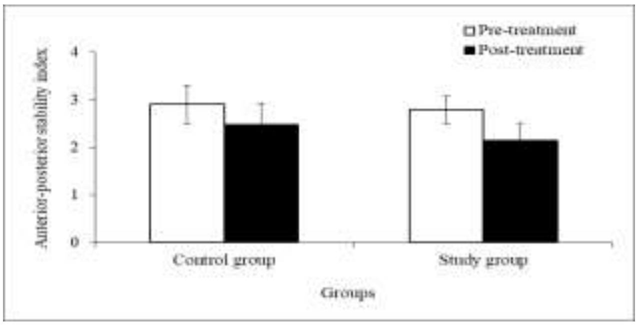

Figure 4: Mean values of before and after treatment APSI in both groups.

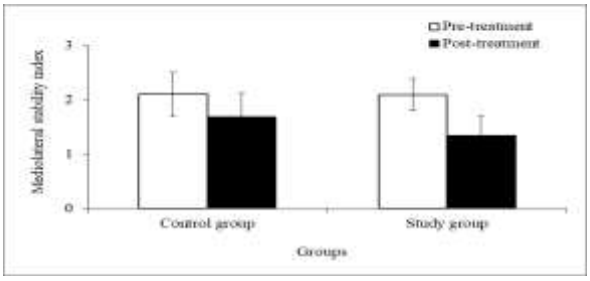

Figure 5: Mean values of before and after treatment MLSI in both groups.

IV. DISCUSSION

A lot of studies of MT have been on the rehabilitation of upper extremity and very limited studies investigated the effect of MT in the rehabilitation of lower extremity, so our study aimed to assess the efficacy of lower extremity MT on balance in hemiplegic cerebral palsy children.

According to **Hadders et al., 1999** [**18**], deficiency of balance control considered one of the most important problems in cerebral palsied children so our study was aimed to improve balance in with hemiplegic cerebral palsy children.

In our current study, the selection of hemiplegic cerebral palsied children supported by **Kennis-Coskun et al., 2016** [**4**], who concluded that poor balance control presented in hemiplegic cerebral palsied

Received: 27 Mar 2020 | Revised: 20 Apr 2020 | Accepted: 05 May 2020

children when compared to those normal children that result from slowed and developmental impairment of neural motor control mechanisms in addition to musculoskeletal abnormalities.

The age of our participant children was from eight to twelve years of old this age supported by **Nolan et al., 2005** [**19**], who stated that, as the visual and vestibular system matured secondary to the maturation of somatosensory system, also the period between the ages of 4 and 6 years has the greatest development of sensory integration that provides alteration in sensory conditions similar to that exhibited by adults when the child is 7 to l0 years of age.

Using MT was related to a simple, inexpensive, and method for patient-orientation [**20**]. It has been reported that it had a great effect in reducing phantom pain sensations after amputation and increase ROM, velocity, arm movement function, and accuracy [**21**]. It also activates the primary motor cortex (M1) [**22**].

Rehabilitation with MT has many advantages such as visual feedback training and imagery training [**23,24**], as it uses visual illusion, that the patients perceive the image that reflected from their normal limb as the affected one [**24**]. It also compensated for the decrease proprioceptive input by receiving the normal visual feedback by showing the image of a normal limb in the mirror [**25**].

The results obtained from pre-treatment evaluation confirm that the mean values of two groups showed significant impairment of the static and dynamic balance of all the participated children, these results agreed with **Sussman & Aiona 2004** [**26**], who suggested that the balance in spastic children become worse between the ages of four and 14 years.

Both groups received the same guideline protocol in the same environment and the way of gathering information and processing was done in the same way. The abilities of readjustment were equal, the gross co-ordination, and the sensory-motor integration process were similar.

The post-treatment results showed that all measured variables have significant improvements in both groups, this may be attributed to that neurodevelopment training that was used resulting in modulation of muscle tone and improving postural alignment this supported by **Ottenbacher et al., 1986** [**27**] who concluded that the guideline protocol (based on neurodevelopment basis) has a direct effect on facilitation of postural control and development of lower extremities and trunk normal movement patterns varieties**.**

The significant improvement results in APSI 2.48±0.44 in (GA) and 2.14±0.37 in (GB) could be attributed to the improvement that occurred in the essential motor component of postural control (ankle strategy) which is an operated mainly during minimal anteroposterior balance disturbance, which supported by **Shumway and Woollacott2007** [**28**], who concluded that ankle strategy help in preventing a fall in the event of a destabilizing perturbation, it restores the center of pressure to a position of stability through body movement centered primarily about the ankle joint controlled by the ankle plantar flexor and dorsiflexor.

The significant improvement in (GB) in all measured variables of dynamic balance such as OASI, APSI, and MLSI were 2.47±0.4, 2.14±0.37 and 1.34±0.62 respectively when comparing pre and post means values after three successful months of treatment may be due to MT that comes in agreement with **Sütbeyaz et**

al. 2007 [**12**], who reported that there was a significant improvement in the lower limb motor recovery and function after 4 weeks of MT in sub-acute stroke patients**.**

Our previously described findings in MLSI1.68±0.48 in (GA) and 1.34±0.62 in (GB) could be attributed to the improvement occurred in the hip strategy which supported by **Runge et al. 1999** [**29**], who emphasized on, large and rapid movement at hip joints with ankles antiphase rotation minimizes the movement of the center of mass, and added that the primary lower limb joint is the hip joint which used in recovering stability in the mediolateral direction.

A randomized clinical trial demonstrated the great effect of MT in post stork rehabilitation it was found that MT provides stimulation of frontal and parietal lobe of the corresponding motor region (area of mirror neurons) [**25**], and according to **Deconinck et al., 2015 [30]**, MT provides visual feedback which can modulate the ipsilesional activity, activates neuronal recruitment and function reorganization of sensory-motor cortex, which helps to establish the link between visual input and movement and then facilitates the recovery of motor function.

Our findings come in agreement with **Galeazzi et al 2006** [31], who concluded that MT improves the balance ability in stroke patients that performed balance training in front of a full-length mirror.

Our previous findings also supported by **Feltham et al2010** [32], who concluded that there were positive effects of using visual feedback of MT on the bilateral coordination ability and neuromuscular activity in patients with spastic hemiplegia.

The significant improvement in our post-treatment results also comes in agreement with **Cui and Cong 2012** [33], who concluded that MT activates the mirror neuron system that promotes brain plasticity and functional reorganization that finally facilitates the motor response.

V. CONCLUSION

It can be concluded that lower extremity mirror therapy has a significant impact on balance in children with hemiplegic cerebral palsy.

Limitations

Further studies with prolonged time of follow-up needed to ensure the maintenance of the statistical results and emphasis that no loss or relapse in all balance indexes after mirror therapy.

REFERENCES

1. **Miller F. and Bachrach S.:** Cerebral Palsy: A complete guide for caregiving. 3rd edition, Part one: What is cerebral palsy? Publisher: John Hopkins University Press, Baltimore **(2017)**; 3-28.
2. **Robert J., Steven E., Peter L., et al.:** Probability of walking, wheeled mobility and assisted mobility in children and adolescents with cerebral palsy. J. Dev. Med. Dev. **(2010);** 52 (1): 66–71.
3. **Chen L., Chen Y., Liaw Y., et al.:** Efficacy of home-based virtual cycling training on bone mineral density in ambulatory children with cerebral palsy. Osteoporosis Int **(2013)**; 24:1399–406.
4. **Kenis-Coskun O., Giray E., Eren B., et al.:** Evaluation of postural stability in children with hemiplegic cerebral palsy. J PhysTherSci **(2016)**; 28(5):1398-1402.

5. **Woollacott M.H. and Shumway-cook A:** Postural dysfunction during standing and walking in children with cerebral palsy: What are the underlying problems and what new therapies might improve balance? Neural Plasticity **(2005)**, 12 (2-3), pp. 211-9,
6. **Gan S.M.:** Psychometric properties of functional balance assessment in children with cerebral palsy. Neurorehabilitation and Neural Repair **(2008)**; 22(6): pp. 745–753.
7. **McInnes K, Friesen C, Boe S.:** Specific brain lesions impair explicit motor imagery ability: A systematic review of the evidence. Arch Phys Med Rehabil. **(2016);** 97(3):478–89.e1.
8. **Funase K, Tabira T, Higashi T, et al.:** Increased corticospinal excitability during direct observation of self-movement and indirect observation with a mirror box. NeurosciLett **(2007)**; 419:108–112.
9. **Cattaneo L. and Rizzolatti G**.**:** The mirror neuron system. Arch Neurol. **(2009)**; 66:557–560.
10. **Summers JJ, Kagerer FA, Garry MI, et al.**: Bilateral and unilateral movement training on upper limb function in chronic stroke patients: a TMS study. J Neurol Sci. **(2007)**; 252:76–82.
11. **Myoung-Kwon Kim, Ph.D., Young-Jun Shin, MS, Eun-Hong Choi, MS**: Effect of Mirror Therapy Combined with Lower Extremity Muscle Strength Exercise on Gait and Balance of Patients with Chronic Stroke (2017)
12. **Sutbeyaz S., Yavuzer G., Sezer N., et al**.**:** "Mirror therapy enhances lower-extremity motor recovery and motor functioning after stroke: a randomized controlled trial," Archives of Physical Medicine and Rehabilitation **(2007)**, vol. 88. No. 5, pp. 555 –559.
13. **Saghaei M.:** Random allocation software for parallel-group randomized trials. BMC Med Res Methodol **(2004)**; 4:26.
14. **El-Shamy S.M.and Abd El-Kafy E.M.:** Effect of balance training on postural balance control and risk of fall in children with diplegic cerebral palsy. DisabilRehabil **(2014)**; 36: 1176–83
15. **Gstöttner M., Neher A., Scholtz A., et al.:** Balance ability and muscle response of the preferred and non-preferred leg in soccer players. Motor Control **(2009)**; 13: 218-31.
16. **Arifin N., Abu Osman N.A., & Wan Abas ..** Interrater test-retest reliability of static and dynamic stability indexes measurement using the Biodex Stability System during unilateral stance. ApplBiomech Apr **(2014)**, 30(2), 300-4.
17. **Levitt S.:** Treatment of cerebral palsy and motor delay, 6th Ed., Blackwell Publishing, Oxford; **(2018),** 157-175.
18. **Hadders M., Fits I., Stremmelaar E., et al.:** Development of postural adjustments during reaching in infants with CP. Developmental Medicine & Child. Neurology **(1999)**, 766,
19. **Nolan L., Grigorenko A., and Thorstensson A.:** Balance control: Sex and Age Differences in 9 to 16 Year-Olds. Developmental Medicine and Child Neurology **(2005)**; 47: 449-454,
20. **Altschuler EL and Hu J.:** Mirror therapy in a patient with a fractured wrist and no active wrist extension. Scand J PlastReconstrSurg Hand Surg **(2008);** 42:110–111.
21. **Zeng W, Guo Y, Wu G, et al.:** Mirror therapy for motor function of the upper extremity in patients with stroke: a meta-analysis. J Rehabil Med **(2018);** 50:8–15.
22. **Garry MI, Loftus A, Summers JJ.:** Mirror, mirror on the wall: viewing a mirror reflection of unilateral hand movements facilitates ipsilateral M1 excitability. Exp Brain Res **(2005);** 163:118–122.
23. **Yavuzer G., Selles R. and, Sezer N.:** Mirror therapy improves hand function in subacute stroke: a randomized controlled trial. Arch Phys Med Rehabil **(2008)**; 89:393–98.
24. **Stevens JA. And Stoykov ME**.**:** Using motor imagery in the rehabilitation of hemiparesis. Arch Phys Med Rehabil **(2003)**; 84:1090e2.
25. **Ltschuler EL., Wisdom SB., and Stone L.:** Rehabilitation of hemiparesis after stroke with a mirror. Lancet **(1999)**; 353:2035–36.
26. **SussmanM. and Aiona M.:** Treatment of Spastic Diplegia in Patients with Cerebral Palsy. Journal of Pediatric Orthopedics **(2004)**. Lippincott Williams & Wilkin: 13:54-59.
27. **Ottenbacher K., Biocca Z., DeCremer G., et al.:** Quantitative Analysis of the Effectiveness of Pediatric Therapy Emphasis on the Neurodevelopmental Treatment Approach. Physical therapy **(1986)**; 66: 1095-1101.
28. **Shumway-Cook A.:** Assessment and Management of the Patient with Traumatic Brain Injury and Vestibular Dysfunction InHerdman S.; Vestibular Rehabilitation. 3rd ed. F.A. Davis Company. Philadelphia **(2007)**: 449-451.
29. **Runge C.F., Shupert C.L., Horak F.B., et al.:** Postural strategies defined by joint torques. Gait Posture **(1999)**, 10: 161-170.

30. **Deconinck, F.J., Smorenburg, A.R., Benham, A., et al.:** Reflections on mirror therapy: a systematic review of the effect of mirror visual feedback on the brain. Neurorehabil. Neural Repair **(2015);** 29 (4), 349–361.
31. **Galeazzi GM, Monzani D, Gherpelli C, et al.:** Posturographic stabilization of healthy participants exposed to full-length mirror image is inversely related to body-image preoccupations. Neurosci Lett **(2006)**; 410:71e5.
32. **Feltham MG, Ledebt A, Deconinck FJ, et al.:** Mirror visual feedback induces lower neuromuscular activity in children with spastic hemiparetic cerebral palsy. Res Dev Disabil **(2010)**; 31:1525e35.
33. **Cui Y and Cong F.:** Basic theory of mirror neuron system and its meanings in motor rehabilitation. J Rehab TheorPract **(2012)**; 18: 239-243.