

## Effect of Vibration Therapy on Shoulder Flexion Range of Motion in Children with Hemiparetic Cerebral Palsy

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### Abstract

**Background:** Cerebral palsy affects a child's ability leading to physical disability. Hemiparetic cerebral palsy has been shown to affect joints' range of motion. Vibration therapy was suggested to improve several musculoskeletal aspects in children with cerebral palsy.

**Aim of Study:** To investigate the effect of vibration therapy on the shoulder joint range of motion in children with hemiparetic cerebral palsy.

**Patients and Methods:** This study included thirty children diagnosed with hemiparetic cerebral palsy of both sexes whose ages ranged from 3 to 6 years old with spasticity of grades 1 and 1+ according to the modified Ashworth' scale and gross ability of levels I and II according to the Gross Motor Function Classification System. They were assigned into two equal groups; the control group received a designed physiotherapy program, and the study group received the same program as the control group in addition to whole body vibration.

**Results:** There was a statistically significant improvement in shoulder range of motion regarding the study group. Additionally, there was a statistically significant difference between the control and study group post-treatment in favor of the study group.

**Conclusion:** Vibration therapy was proven to have a beneficial effect on shoulder flexion range of motion in children with hemiparetic cerebral palsy.

**Key Words:** Cerebral palsy — Hemiparesis — Whole body vibration — Shoulder flexion range of motion.

### Introduction

**CEREBRAL** palsy (CP) is the most common motor disability in childhood that affects a child's ability to move and maintain balance and posture. It de-

scribes a group of disorders in the development of movement and posture, causing activity limitation which is attributed to non-progressive disturbances that occur in the developing fetal or infant brain. These motor disorders of CP are often accompanied by disturbances of sensation, cognition, communication, perception, behavior, and/or seizure disorder [1].

There are types of cerebral palsy; it may be spastic, ataxic, dyskinetic or hypotonic. Spastic variety is further classified into quadriplegic, diplegic, hemiplegic and monoplegic [2].

Hemiplegia is a non-progressive disorder that results in severe paralysis on one side of the body and is caused by brain or spinal cord injury. Hemiparesis emanates from hemiplegia but is in a form of mild paralysis on one side of the body. Depending on the location and severity of the injury, the degree of hemiplegic symptoms varies; as it may include muscle stiffness or weakness on one side, spasticity of muscles, poor fine motor skills, difficulty walking, unsteadiness, and difficulty grasping objects [3].

Hemiparesis is a mild paralysis on one side of the body. It results in muscular wasting on the affected side of the body; especially the upper limbs, impairs gait, reduces motor abilities, and causes instability and loss of grasping capacity. It also impacts the patient's quality of life as it impairs brain and spinal cord functions [3].

Vibration therapy (VT), as a type of weight-bearing therapeutic modality, has been implemented in rehabilitation programs for children with CP. Moreover, it has been suggested that VT stimulates proprioception, inducing spinal and cortical reorganization and, consequently, improving motor control [4].

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The mechanism by which vibration therapy elicits therapeutic effect is thought to involve the change in height of the vibration platform resulting in altered muscle length followed by a change in tension in the muscle spindle. This elicits a spinal reflex response involving contraction of muscles to recover the tension in the muscle spindle [5]. Furthermore, VT is considered a safe and effective method [6].

## Patients and Methods

### Study design:

Randomized controlled clinical trial.

### Ethical consideration:

Approval was conducted by the Local Ethical Committee at the Faculty of Physical Therapy, Cairo University (No: P.T.REC/012/004333). A signed informed consent was obtained from each child's parent.

### Subjects:

This study was conducted from January 2023 to August 2023. Children diagnosed with hemiparetic CP were recruited based on a pilot study according to the inclusion and exclusion criteria. They were selected from El-Qanater Central Hospital, Kaliobeya Governorate, Egypt.

### Inclusion criteria:

Children of both sexes were included if they; (1) were of age group ranging from 3 to 6 years, (2) were diagnosed with hemiparetic cerebral palsy, (3) had spasticity of grades 1 and 1+ according to the Modified Ashworth' scale, (4) were level I and II according to Gross Motor Function, (5) could understand and follow commands given by the therapist.

### Exclusion criteria:

Children were excluded if they; (1) had a history of convulsions and epilepsy, (2) had impaired cognitive function, (3) had any surgical procedure for correction of deformity or soft tissue release in the past year.

All the included children were randomly assigned to one of two groups of equal numbers (n=15) for each group. Regarding the control group, children received a conventional physical therapy program while the study group received the same conventional program of controls in addition to whole-body vibration therapy for the shoulder joint.

### Methods:

#### Evaluation procedure:

The assessment of joint range of motion (ROM) is considered an important component of physical therapy examination, providing baseline data, determining functional limitations, and monitoring

changes in joint mobility in response to treatment. Measurement of ROM may also be used to detect asymmetry and movement restrictions that may increase the risk of injury. The Universal Goniometer (UG) has been considered the gold standard for the clinical assessment of ROM; additional tools such as digital goniometers have been used [7].

For dynamic measurements, a digital goniometer (**DG**) is the most reliable tool which has a low measurement error [8] and demonstrates statistically equivalent reliability values to the universal goniometer (UG). However, it would produce higher reliability values than the UG where the lack of a statistically significant difference between the two devices implies that the two devices could be used interchangeably for clinical measurements of ROM [9].

Thus, in this study a digital goniometer was used for the evaluation of the shoulder flexion range of motion pre and post-treatment.

### Treatment procedure:

Regarding the control group, children received daily physical therapy program to improve the gross motor functions. The exercises performed included passive stretching exercises for elbow and wrist flexors, weight-bearing exercises for the upper limbs, stimulation of the protective reactions of the upper limbs in all directions, and strengthening exercises for antagonists of the spastic muscles, including elbow and wrist extensors, using different toys and motivation to encourage the children to perform the desired exercises [10]. The treatment session lasted for 1 hour 5 days / week for 4 weeks.

Regarding the study group, children received the same physical therapy program as that of the control group for half an hour followed by whole body vibration (WBV) for half an hour. Each child was seated on an armless chair in front of the platform and instructed to flex both shoulders at 90°, slightly bend both elbows, and then bend the trunk forward to allow both hands to be placed on the platform. Each subject was allowed to hold the palms slightly off the platform to minimize discomfort and prevent strong stimulation of the organs, eyes, and head.

## Results

### 1- Control group:

Statistical analysis of this group was studied pre and post treatment. The results showed non-significant improvement where the mean value of the shoulder flexion before treatment was  $147 \pm 3.4$  degree with a minimum value of 142 and a maximum value of 152. While the mean value of the post-treatment was  $150 \pm 3.3$  with a minimum value of 145 and a maximum value of 155 ( $p=0.2$ ) as shown in Table (1).

Table (1): Shoulder flexion of control group pre and post-treatment.

	X	SD	Min	Max	t	p	Significance
Pre	147	±3.4	142	152	1.34E-9	0.2	NS
Post	149	±3.3	145	155			

X : Mean.  
SD : Standard Deviation.  
Min : Minimum.  
Max : Maximum.

t : t-test.  
p : Probability value.  
NS : Non-significant.

2- Study group:

The results of shoulder flexion range of motion for this group pre and post-treatment represented significant improvement, where the mean value pre-treatment was 143±3.8 with a minimum value of 141 and a maximum value of 153. While the mean value post-treatment was 147±4 with a minimum value of 141.4 and a maximum value of 155 (p=0.05) as shown in Table (2).

Table (2): Shoulder flexion of study group pre and post-treatment.

	X	SD	Min	Max	t	p	Significance
Pre	143	±3.8	141	153	2.345E-9	0.05	S
Post	147	±4	141.4	155			

X : Mean.  
SD : Standard Deviation.  
Min : Minimum.  
Max : Maximum.

t : t-test.  
p : Probability value.  
NS : Non-significant.

Discussion

The present study was conducted to investigate the effect of WBV on shoulder flexion ROM in children with hemiparetic CP. Shoulder flexion ROM was measured by a digital goniometer, it was considered as a reliable measuring tool for the shoulder flexion ROM. The application of WBV was found to improve shoulder flexion ROM after 5 sessions/week for 4 weeks.

The vibrations produced stimulate the contracting muscle spindles and alpha motor neurons in accordance with the tonic vibration reflex. Stimulation of these reflexive muscle contractions alongside voluntary muscle contractions has been proposed as a method of improving function [11].

Whole-body vibration (WBV) was found to increase the muscular activity around the shoulder joint with a vibration frequency of 35 Hz, although a higher vibration frequency may also be effective according to Morikawa [12].

Moreover, vibration at approximately 5Hz was found to cause simultaneous contraction of both the shoulder and trunk muscles; improving muscular strength and stability in the shoulders and trunk,

and enhancing the proprioceptive sensation [13]. Also, local vibration was found to be an effective treatment for shortening and stiffness of muscle or fascia tissue [14].

It was found that the use of whole-body vibration training combined with task-related training such as static weight bearing and reaching activities has more benefits on the improvement of arm function regarding the range of motion of shoulder flexion, elbow extension, and forearm supination, spasticity, and maximal grip strength regarding shoulder abduction, wrist flexion, and wrist extension than conventional upper limb training alone [15].

Conclusion:

Improvement in shoulder flexion range of motion can be gained by adding WBV to the physiotherapy program of children with hemiparetic CP. Moreover, significant changes could be detected within and between groups.

References

- 1- FROSLEV-FRIIS C., DUNKHASE-HEINL U., ANDERSEN J., STAUSBOL-GRON B., HANSEN A.V. and GARNE E.: Epidemiology of cerebral palsy in southern Denmark. Danish Medical Journal, 62: A4990, 2015.
- 2- KHAN S.A., TALAT S. and MALIK Mi.: Risk factors, types, and neuroimaging findings in Children with Cerebral Palsy. Pakistan Journal of Medical Sciences, 38 (7): 1738, 2022.
- 3- VARMA A., KHAN NR., VARMA A., SHARMA N.S., VAGHA JD., NAQVI W.M., BESEKAR S., VARMA SR A., KHAN N., SHARMA SR N.S. and BESEKAR S.M.: Pediatric Patients With Hemiplegia: A Systematic Review of a Randomized Controlled Trial. Cureus, Jan. 23; 15 (1), 2023.
- 4- ADAIKINA A., DERRAIK J.G., TAYLOR J., O'GRADY G.L., HOFMAN P.L. and GUSSO S.: Vibration Therapy as an Early Intervention for Children Aged 2-4 Years with Cerebral Palsy: A Feasibility Study. Physical & Occupational Therapy In pediatrics, Mar. 3: 1-8, 2023.
- 5- WARMAN G., HUMPHRIES B. and PURTON J.: The effects of timing and application of vibration on muscular contractions. Aviation, space, and environmental medicine, 73 (2): 119-127, 2002.
- 6- KO M.S., SIM Y.J., KIM D.H. and JEON H.S.: Effects of three weeks of whole-body vibration training on joint-position sense, balance, and gait in children with cerebral palsy: A randomized controlled study. Physiotherapy Canada, 68 (2): 99-105, 2016.
- 7- CORRELL S , FIELD J , HUTCHINSON H., MICKEVICIUS G., FITZSIMMONS A. and SMOOT B.: Reliability and validity of the halo digital goniometer for shoulder range of motion in healthy subjects. International journal of sports physical therapy, 13 (4): 707, 2018.

- 8- PIRIYAPRASARTH P. and MORRIS M.E.: Psychometric properties of measurement tools for quantifying knee joint position and movement: A systematic review. *The Knee*, 14 (1): 2-8,2007.
- 9- GOODWIN J., CLARK C., DEAKES J., BURDON D. and LAWRENCE C.: Clinical methods of goniometry: A comparative study. *Disability and Rehabilitation*, 14 (1): 10-15, 1992.
- 10-EL-SHAMY S.M.: Efficacy of Armeo® robotic therapy versus conventional therapy on upper limb function in children with hemiplegic cerebral palsy. *American Journal of Physical Medicine & Rehabilitation*, 97 (3): 164-169, 2018.
- 11-CARDINALE M. and BOSCO C.: The use of vibration as an exercise intervention. *Exercise and sport sciences reviews*, 31 (1): 3-7,2003.
- 12-MORIKAWA M., URABE Y., KOTOSHIBA S., YOSHIMI M. and MAEDA N.: Acute effects of different whole-body-vibration frequencies on shoulder stability. *Gait & Posture*, 81: 230-231,2020.
- 13-LEE DK., KIM Y.N., PARK C.B. and PARK M.S.: The effect of actively induced vibration using shoulder joint on pain and dysfunction in patients with low back pain. *Journal of Physical Therapy Science*, 30 (1): 23-26,2018.
- 14-JUNG S.H. and HA S.M.: Effects of local vibration on shoulder horizontal adduction and internal rotation range of motion in subject with posterior shoulder tightness. *Journal of Musculoskeletal Science and Technology*, 4 (2): 66-69,2020.
- 15-LEE J.S., KIM C.Y. and KIM HD.: Short-term effects of whole-body vibration combined with task-related training on upper extremity function, spasticity, and grip strength in subjects with post stroke hemiplegia: A pilot randomized controlled trial. *American Journal of Physical Medicine & Rehabilitation*, 95 (8): 608-617,2016.

## تأثير العلاج بالاهتزاز على مدى انثناء حركة الكتف لدى الأطفال المصابين بالشلل الدماغى النصفى

**الخلفية:** يؤثر الشلل الدماغى على قدرة الطفل مؤدياً إلى إعاقة جسدية. تبين أن الشلل الدماغى النصفى يؤثر على نطاق حركة المفاصل. لذلك اقترح العلاج بالاهتزاز لتحسين العديد من الجوانب العضلية الهيكلية لدى الأطفال المصابين بالشلل الدماغى.

**الهدف من الدراسة:** دراسة تأثير العلاج بالاهتزاز على نطاق حركة مفصل الكتف لدى الأطفال المصابين بالشلل الدماغى النصفى.

**المرضى وآليات العمل:** شملت هذه الدراسة ثلاثين طفلاً مصاباً بالشلل الدماغى النصفى من كلا الجنسين تراوحت أعمارهم بين ٣ إلى ٦ سنوات مع تشنج من الدرجتين ١ و١+ حسب مقياس أشورث المعدل والقدرة الإجمالية للمستويين الأول والثانى حسب نظام تصنيف الوظائف الحركية الإجمالية. تم تقسيمهم إلى مجموعتين متساويتين؛ تلقت المجموعة الضابطة برنامجاً مصمماً للعلاج الطبيعى، وتلقت مجموعة الدراسة نفس برنامج المجموعة الضابطة بالإضافة إلى اهتزاز الجسم بالكامل.

**النتائج:** كان هناك تحسن ذو دلالة إحصائية فى نطاق حركة الكتف فيما يتعلق بمجموعة الدراسة. بالإضافة إلى ذلك، كان هناك فروق ذات دلالة إحصائية بين المجموعة الضابطة والمجموعة الدراسية بعد العلاج لصالح مجموعة الدراسة.

**الاستنتاج:** ثبت أن العلاج بالاهتزاز له تأثير مفيد على نطاق حركة انثناء الكتف لدى الأطفال المصابين بالشلل الدماغى النصفى.