OPEN ACCESS

ORIGINAL ARTICLE

Assessment of Handgrip Strength in Spastic Diplegic Cerebral Palsy Children

Ali Mehmood[1], Haseeb ullah Ammad[2], Muhammad Faheem Afzal[3], Anila Amjad[4], Atiba Saeed[5], Aqsa Hasnat[6]

[1, 6] Physical Therapist, PSRD College of Rehabilitation Sciences, Lahore, Pakistan
[2] Principal, PSRD College of Rehabilitation Sciences, Lahore, Pakistan
[3] Assistant Professor, PSRD College of Rehabilitation Sciences, Lahore, Pakistan
[4] Lecturer, PSRD College of Rehabilitation Sciences, Lahore, Pakistan
[5] Demonstrator, PSRD College of Rehabilitation Sciences, Lahore, Pakistan

Author`s Contribution

[2-5] Conception and design, Collection and assembly of data, [1]Analysis and interpretation of the data, 1Critical revision of the article for important intellectual content, Statistical expertise [1-5] Final approval and guarantor of the article.

Article Info.

Received: Sep 15, 2022
Acceptance: March 18, 2023

Conflict of Interest: None
Funding Sources: None

Address of Correspondence

Ali Mehmood
Email: alimehmood432@gmail.com
ORCID: 0000-0002-9312-1017

Cite this article as: Mehmood A, Ammad HU, Afzal MF, Amjad A, Saeed A, Hasnat A. Assessment of Handgrip Strength in Spastic Diplegic Cerebral Palsy Children. JRCRS. 2023; 11(3):164-168.
DOI:https://doi.org/10.53389/JRCRS.2023110307

A B S T R A C T

Objective: The objective of this study was to assess the handgrip strength difference by using a handheld dynamometer in spastic diplegic cerebral palsy children.

Methodology: Descriptive cross-sectional study design was done by utilizing a non-probability purposive sampling technique. The study was held at the Pakistan Society of Rehabilitation and Disabled Hospital, Lahore from August 2021 to January 2022. The sample size was 69 calculated by using select-statistics.co.uk with a 5% precision level, both genders of aged 7 to 12 years, and only those having spastic diplegia involving both upper extremities were included. A handheld dynamometer was used for the handgrip strength measurements and data was entered into the self-structured questionnaire. The results are calculated by using sample-paired tests using SPSS.

Results: The mean age was 9.014±2.096years, height was 113.67±19.246cm, weight was 20.101±8.711kg, & BMI was 14.907±3.368kg/m2. The mean of the right affected handgrip and the left affected handgrip of cerebral palsy children was 3.744±1.634 & 3.698±1.607 respectively with a p-value > 0.05.

Conclusions: It was concluded from the study that there were no statistical differences between right and left handgrips of spastic diplegic cerebral palsy children.

Keywords: Cerebral Palsy, Handgrip Strength, Muscle Strength Dynamometer, Muscle Spasticity.

.

Introduction

Cerebral palsy (CP) is a broad term that describes the spectrum of movement and postural abnormalities as well as motor function impairments that causes activity limitation and are caused by nonprogressive disturbances in the developing fetal brain.[1]

In preterm newborns, there is a high risk of intraparenchymal hemorrhages within the germinal matrix, especially around the junction between the developing thalamus and caudate nucleus. Hemorrhages can either be isolated or can spread via a ventricular system to the subarachnoid space causing hydrocephalus. Thinned out gliotic gyri results in the perinatal ischemic lesion of the cerebral cortex. The consequence of ischemic damage to the basal ganglia and thalamus is patchy neuronal loss and reactive gliosis. Later on, there is abnormal and variable myelinization which causes the deep nuclei to assume a marble-like appearance (status marmoratus). A lesion in the caudate, putamen and thalamus can result in movement abnormalities such as choreoathetosis.[2]

In most cases, the only risk factor for cerebral palsy is hypoxia (HIE, hypoxic-ischemic encephalopathy).[3] The risk factors for cerebral palsy can be categorized into three classes:

(A) Prenatal: prematurity (age of gestation less than 36 weeks), low birth weight (less than 2,500g), infection (toxoplasmosis, Cytomegalovirus, Herpes Simplex Virus), multiple pregnancies and vaginal bleeding. (B) Perinatal: vacuum-assisted delivery, forceps delivery, meconium aspiration syndrome, and birth asphyxia. (C) Postnatal: head trauma, meningitis, encephalitis, and kernicterus.[4,5]

Cerebral palsy is an upper motor neuron (UMN) lesion. The following are the sign and symptoms of UMN lesion spasticity, hyperreflexia, clonus, extensor plantar responses, and primitive reflexes. Spasticity is a disorder in which the physiological resistance of muscles to passive movement increases as the speed of movement increases.[6]

We used to classify cerebral palsy based on motor impairments. Spastic cerebral palsy comprises 80% to 90% of children with cerebral palsy.[7] Spastic cerebral palsy is further classified into hemiplegic, diplegic, and quadriplegic cerebral palsy. Hemiplegia encompasses 25% of children with spastic cerebral palsy & affects one side of the body with the upper extremities being more afflicted than the lower extremities.[8] Diplegia encompasses 35% of children with spastic cerebral palsy with the lower extremities are greatly influenced than the upper extremities. In diplegia, MRI reveals periventricular leukomalacia. Prematurity and low birth weight affect certain babies. Quadriplegia encompasses 20% of spastic cerebral palsy. In quadriplegia, all four limbs along with the trunk and muscles that control the mouth, tongue, and throat are affected. It is common to have a history of prematurity and hypoxic-ischemic encephalopathy. Lesion to basal ganglia results in dyskinetic cerebral palsy which accounts for 10% to 15%, further categorized into dystonic CP and choreoathetotic CP.[9] Classification of cerebral palsy based on motor function loss (GMFCS) is used to describe the capacity to walk. GMFCS describes both self-initiated movements and assisted movements that are assisted by walkers, crutches, canes, or wheels.[10]

A handheld dynamometer (HHD) is a specific, evidence-based, and eco-friendly device to determine handgrip strength. HHD can be used for grip and pinch strength, and less typically for lingual and orbicularis oris strength.[11] The Jamar dynamometer is an appropriate tool for the assessment of grip strength. HHD is postulated for evaluating various upper extremity muscle groups.[12]

In children with diperitic cerebral palsy handgrip, dexterity, and hand functions were all adversely affected and the results were statistically significant i.e. $P < 0.05$. The rehabilitation program for diperitic CP children focused on the ADLs-oriented functional approaches.[13]

A study was conducted in which researchers differentiate between the dominant and non-dominant handgrip strength. A statistically significant difference was found in children at MACS level II, albeit this was significant for wrist extensors. Children with cerebral palsy did not develop their wrist extensors at the rate as those children with typical development.[14]

The purpose of this study was to assess the handgrip strength by using a handheld dynamometer in spastic diplegic cerebral palsy children. As most researchers studied the strength in lower extremity, gait, and functioning. Very few studies told us about the handgrip strength and upper extremity strength in spastic diplegic cerebral palsy children. By determining the handgrip strength physical therapists helped to maintain strength in cerebral palsy children. If they make the perfect assessment they could make a perfect treatment plan. The better the treatment plan the sooner the effects will come.

Methodology

Descriptive cross-sectional study design using a non-probability convenient sampling technique was used. The study's duration was 6 months after the approval of the synopsis from August 2021 to January 2022. The study was conducted at the Pakistan Society of Rehabilitation and Disabled Hospital (PSRD), Lahore. The sample size of the study was 69 with a 5% precision level. The children with age 7 to 12 years, both male and female, chronic stage spastic diplegic children who had diplegia in the upper extremities were recruited. Those children with the pathological complications of CP and those who had any trauma or fracture were excluded.

Demographic information such as age, height, weight, BMI, and gender of subjects has been taken by the patients who can provide detail by themselves, otherwise guardians who came with them provide information about the subject enrolled in the study. A hand-held microfed and jamar dynamometer (HHD) was used to measure the handgrip strength in spastic diplegic cerebral palsy children bilaterally. All those children who were properly assessed and examined by the physical therapy and occupational therapy department and who meets the inclusion criteria were selected.

Ethical request has been taken by the Institutional Review Board (IRB) of the Pakistan Society for the Rehabilitation of Disabled (PSRD) College of Rehabilitation Sciences (PSRD/CRS/AM/REC//Letter007). The guardians of the patients filled out the consent form then the patients were approached and a standardized method was used to measure the handgrip strength then the data was entered into the self-structured questionnaire.

Statistical Package for Social Sciences (SPSS) software computer program version 26 was used to analyze data which was presented as graphs and tables. Quantitative variables like age, height, Body Mass Index, and dynamometer readings were expressed as mean and standard deviation and paired sample test was applied to determine the significant difference.

Results

Demographic characteristics of the children's age, height, weight, and BMI are described in (Table I). In this study total of 69 participants were recruited, 41 (59%) were males and 28 (40%) were females, and all of them can follow commands and participate in the assessment by a dynamometer. The results showed that there is no significant difference between right and left handgrip strength in spastic diplegic cerebral palsy children as the p-value = 0.63

Table I: Demographic information of the subject. (n=69)

	N	Min	Max	Mean±SD
Mean of Age (Year) in CP children	69	7.0	12.0	9.01±2.1
Mean of Height (cm) in CP children	69	85.0	156.0	113.67±19.25
Mean of Weight (Kg) in CP children	69	8.0	35.0	20.1±8.71
Mean of Body Mass Index (kg/m^2) in CP children	69	7.39	27.10	14.91±3.37

The difference in the mean of right and left handgrip strength is described in (Table II). There is no greater difference in strength across the age group of 7 to 12 years. Paired sample test was applied to see if there was a difference in handgrip strength in children with spastic diplegic cerebral palsy.

Table II: Right and Left Handgrip Strength.

Paired Samples Test

	Paired Differences		
	Mean	SD	P value
Assessment of handgrip of right affected hand by using a handheld dynamometer - Assessment of handgrip of left affected hand by using a handheld dynamometer	.04638	.80633	.634

Discussion

Grip strength measurement is an integral part of hand rehabilitation. It determines the limitations of the patient at the start of the treatment and provides a critical appraisal of the progress of the patient throughout the treatment. Under normal biokinetic conditions, the patient produces the forceful flexion of all the finger joints with a maximum voluntary force which produces a handgrip.[15] Many conditions affect grip strength and many of them were highlighted in some studies. One of the known factors is cerebral palsy. Flexors and extensors muscles of the hand act synergistically and the relationship of muscle groups is the important factor in determining the strength of the resulting grip.[16] Many factors like fatigue, hand dominance, time of the day, state of nutrition, age, cooperation of the patient, the presence of amputation, limited motion, pain and sensory loss can afflict the strength of the handgrip. This study compared the left and right handgrip strength of children with spastic diplegic cerebral children by using a handheld dynamometer.

Concerning recent studies, results of the study show that the grip strengths are weaker on the right side of cerebral palsy children. There were only 20% of the patients had a stronger right-hand grip while those with significant left handgrip 33.33%. The researchers conducted a study on 48 diplegic cerebral palsy children and found that 48% of CP patients had higher grip strength values on the left side while this percentage for the right side patients was only 6.9%. There is a general rule according to which the dominant hand is 10% stronger than the non-dominant hand.[17] Hence this rule has not been proved in this study concerning some other studies. The 10% rule was back in time to 2013 when researchers noted that there had been a 5% to 10% difference between left and right handgrip on measurements.[18] Researchers raised questions about the 10% rule and whether it could apply to the whole population with neurological problems. They found 12.7% stronger left handgrip strength in CP patients. In our patient score for the right handgrip strength was greater as compared to the left handgrip strength. So we acknowledged that the 10% rule cannot be generalizable to the whole population with neurological problems affecting the muscle groups. While interpreting these results we must take into consideration that we are living in the world mostly designed for right handedness. Most tools and appliances are designed for the right hand. Grip strength measurements were performed with a handheld dynamometer between fingers and palms of both hands. The data of this study indicate that there is less difference in the strength patterns of left and right hands for handgrip values and the right side has more good grip. Generally, a normal child requires around 5 Kgs of energy to perform normal daily activities and

our study showed that the mean of around 3.5 Kgs, so it is concluded that spastic diplegic CP children had differences in both sides of hand grips but that was not even sufficient to perform minimal daily tasks.[19]

According to the study for detecting isolated muscle strength, handheld dynamometry appeared to be the most sensitive and specific method. Because motor proficiency, balance, and coordination may interfere with the functional assessments, their validity has been questioned. In the context of measuring handgrip strength in patients with CP was difficult, and patients who were able to conduct strength assessments had lower muscle strength. For future examinations of muscle strength and its interference, handheld dynamometry is chosen over functional assessments. [20]

The limitations of this study were the age of 7 to 12 years of children means that the results applied to only this age group. We considered a cross-sectional study design; a longitudinal design might be more appropriate, but it would be more difficult to carry out. We executed a non-probability purposive sampling technique; however, we might use a probability sampling technique to generalize our findings to a population comparable to the study's population and a setting similar to the study's setting.

We recommended for further studies that the study should be performed with a large sample size and probability sampling technique to ensure the generalizability of the results. The study should be carried out over a long period (minimum of one year) for the accuracy of the results.

Conclusion

It was concluded from the study that there were no statistical differences between right and left handgrips of spastic diplegic cerebral palsy children.

ACKNOWLEDGMENT: All praise be to Allah, Most Gracious and Most Merciful, for the strength and His blessings in enabling me to finish this research and my article so far, as well as for giving me the courage and strength to do so. I express my gratitude to my parents. Their advice and careful guidance were indispensable and irreplaceable. My appreciation to my colleagues Dr. Ghazal Azhar, Dr. Aleena Jafar, and Dr. Nayab Iqbal for giving me an exceptionally helpful guideline, their encouragement, and insightful comments are a continuous source of motivation for me. My sincere thanks to the entire faculty of PSRD College of Rehabilitation Sciences, my family, and my friends for their support and encouragement.

Conflict of interest: None
Funding Source: None

References

1. Dekkers KJ, Rameckers EA, Smeets RJ, Gordon AM, Speth LA, Ferre CL, et al. Upper Extremity Muscle Strength in Children With Unilateral Spastic Cerebral Palsy: A Bilateral Problem? Physical Therapy. 2020;100(12):2205-16.
2. Hagel C. Neuropathology of cerebral palsy. Cerebral Palsy: Springer; 2018. p. 35-47.
3. Korzeniewski SJ, Slaughter J, Lenski M, Haak P, Paneth N. The complex aetiology of cerebral palsy. Nature Reviews Neurology. 2018;14(9):528-43.
4. Sadowska M, Sarecka-Hujar B, Kopyta I. Cerebral palsy: Current opinions on definition, epidemiology, risk factors, classification and treatment options. Neuropsychiatric Disease and Treatment. 2020;16:1505.
5. Vitrikas K, Dalton H, Breish D. Cerebral palsy: an overview. American family physician. 2020;101(4):213-20.
6. Iskra D, Kovalenko A, Koshkarev M, Dyskin D. Spasticity: from pathophysiology to treatment. Zhurnal nevrologii i psikhiatrii imeni SS Korsakova. 2018;118(10):108-14.
7. Te Velde A, Morgan C, Novak I, Tantsis E, Badawi N. Early diagnosis and classification of cerebral palsy: an historical perspective and barriers to an early diagnosis. Journal of Clinical Medicine. 2019;8(10):1599.
8. Sadowska M, Sarecka-Hujar B, Kopyta I. Cerebral palsy: current opinions on definition, epidemiology, risk factors, classification and treatment options. Neuropsychiatric disease and treatment. 2020:1505-18.
9. Patel DR, Neelakantan M, Pandher K, Merrick J. Cerebral palsy in children: a clinical overview. Translational pediatrics. 2020;9(Suppl 1):S125.
10. Gulati S, Sondhi V. Cerebral palsy: an overview. The Indian Journal of Pediatrics. 2018;85(11):1006-16.
11. Aertssen W, Smulders E, Smits-Engelsman B, Rameckers E. Functional strength measurement in cerebral palsy: feasibility, test–retest reliability, and construct validity. Developmental Neurorehabilitation. 2019;22(7):453-61.
12. Dekkers KJ, Rameckers EA, Smeets RJ, Janssen-Potten YJ. Upper extremity strength measurement for children with cerebral palsy: a systematic review of available instruments. Physical Therapy. 2014;94(5):609-22.
13. Elbasan B, Bozkurt E, Oskay D, Oksuz C. Upper extremity impairments and activities in children with bilateral cerebral palsy. 2017.
14. Eek MN, Lidman G. Arm Muscle Strength in Children with Bilateral Spastic CP. Physical & Occupational Therapy In Pediatrics. 2021;41(5):529-39.
15. Alkholy WAS, El-Wahab MSE-D, Elshennawy S. Hand grip strength in relation to anthropometric measures of school children: a cross sectional study. Annals of Medical and Health Sciences Research. 2017.
16. Von Walden F, Jalaleddini K, Evertsson B, Friberg J, Valero-Cuevas FJ, Pontén E. Forearm flexor muscles in children with cerebral palsy are weak, thin and stiff. Frontiers in Computational Neuroscience. 2017;11:30.
17. Karthik M, Mahantha M. Motor performance of dominant and non-dominant hand in right-handed and lefthanded children. JMSCR. 2018;6:144-9.

18. Omar MT, Alghadir AH, Zafar H, Al Baker S. Hand grip strength and dexterity function in children aged 6-12 years: A cross-sectional study. Journal of Hand Therapy. 2018;31(1):93-101.
19. Schwab SM, Grover FM, Abney DH, Silva PL, Riley MA. Children and adolescents with cerebral palsy flexibly adapt grip control in response to variable task demands. Clinical Biomechanics. 2020;80:105149.
20. Wyers L, Verheyen K, Ceulemans B, Schoonjans A-S, Desloovere K, Van de Walle P, et al. Strength measurements in patients with Dravet Syndrome. European Journal of Paediatric Neurology. 2021;35:100-10.