ORIGINAL ARTICLE

The effects of ankle mulligan mobilisation in children with cerebral palsy: A randomized single blind control study

Ratib Shaban Ragheb Abushameh[1], Zehra Guchan Topcu[2], Ayse Nur Tunal[3], Akram Amro[4], Azzam Al Arab[5]

Abstract

Objective: To assess the impact of range of motion changes before and after Mulligan mobilisation with ankle movement interventions on the daily lives of children with diplegic cerebral palsy.

Method: The single blind randomised controlled study was conducted from July 30, 2022, to January 10, 2023, at 3 rehabilitation centres in Hebron, Palestine, after approval from the ethics review committee of Eastern Mediterranean University, Northern Cyprus, and comprised children with cerebral palsy, who were randomised into intervention group IG and control group CG. All the subjects received regular physiotherapy sessions, overseen by their parents, while those in group IG received mobilisation with ankle movement treatment 3 times per week for 4 weeks. Post-intervention assessment of ankle range of motion, balance, functional performance and quality of life was done using a goniometer, the timed up and go test, 88-item gross motor function measure, 6-minute walk test and the cerebral palsy quality of life questionnaire. Data was analysed using SPSS 24.

Results: Of the 64 patients, 40(63%) were girls, and 24(37%) were boys. The overall age range was aged 4-12 years. There were 32(50%) patients in each of the two groups. Mobilisation with movement had a significant effect on active and passive range of motion for the left and right ankles ($p<0.05$) as well as on balance, gross motor function and quality of life ($p>0.05$). However, mobilisation with movement had no significant effect on the the distance covered during the 6-minute walk test ($p>0.05$).

Conclusion: Mobilisation with movement had a significant impact on active and passive ankle range of motion, balance and quality of life in diplegic children with cerebral palsy, but it had no impact on gait function.

Clinical trial registration number: The study was registered at the United States National Institutes of Health (ClinicalTrials.gov) with registration number NCT05500924.

Keywords: Cerebral palsy, Mobilisation, Range of motion, Function, Quality of life. (JPMA 74: 1219; 2024)

DOI: https://doi.org/10.47391/JPMA.10328

Introduction

Cerebral palsy (CP) is recognised as one of the most prevalent movement disorders affecting children. It is characterised by chronic, non-progressive movement and postural problems resulting from defects in the developing foetal or infant brain.[1] While CP primarily manifests with neurological symptoms, musculoskeletal pathology also causes significant challenges.[2] Individuals with CP experience lifelong musculoskeletal issues due to underlying neuromotor deficits that impede their engagement in physical activities, with up to 30% of ambulatory children ultimately losing their ability to walk.[3]

Physiotherapy (PT) plays a critical role in managing with impairments, promoting functional abilities, and optimising the potential of children with CP. Physiotherapy interventions aim at improving restricted activities, enhancing functional skills, and facilitating participation through various approaches and modalities.[4] Techniques such as Bo bath, sensory integration therapy, proprioceptive neuromuscular facilitation, and other dynamic PT methods are commonly employed.[4]

Among the affected areas, the ankle joints of children with spastic diplegic CP exhibit notable limitations.[5] Ankle spasticity contributes to restricted ankle joint movement, compromised gait performance, and impaired balance.[6,7] Enhancing ankle range of motion (ROM) has the potential to positively influence balance and gait outcomes.[8] Consequently, improving ankle function and physical capacity represents a key objective in PT practice for addressing musculoskeletal issues in children with neurological conditions.

Progressive orthopaedic complications in children with CP impede their functional progress, often resulting in the regression of previously achieved milestones when their functional status can no longer meet the demands of

[1-3]Department of Physical Therapy and Rehabilitation, Eastern Mediterranean University, North Cyprus, Turkiye; [4]Department of Physical Therapy and Rehabilitation, Alquds University, Palestine; [5]Department of Physical Therapy and Rehabilitation, Palestine Ahliya University, Palestine.

Correspondence: Nanik Ram. e-mail: nanikkhatwani@yahoo.com

ORCID ID. 0000-0001-5962-8343

Submission complete: 26-07-2023 **Review began:** 05-09-2023

Acceptance: 03-04-2024 **Review end:** 14-02-2024

growth.[9] Neurological dysfunction and progressive secondary complications contribute to the inefficiency and increased effort required for walking.[9] However, there is a lack of information and evidence regarding the impact of orthopaedic therapies on orthopaedic secondary problems in children with CP.[10]

The current study was planned to address the knowledge gap by assessing the impact of ROM changes before and after Mulligan mobilisation with ankle movement interventions on the daily lives of children with diplegic CP in terms of all dimensions of the International Classification System (ICF).[11]

Patients and Methods

The single blind randomised controlled trial (RCT) was conducted from July 30, 2022, to January 10, 2023, at 3 rehabilitation centres in Hebron, Palestine, after approval from the ethics review committee of Eastern Mediterranean University (EMU), Northern Cyprus.

The sample size was calculated using Interrater Consistency Formula (ICF) G*Power version 3.1.9.2. The minimum sample size deemed acceptable for this study was determined to be no fewer than 60 children, based on considerations including repeated measures, within–between interaction=0.05, β=0.2, Pillai V=0.1, and an effect size of 0.37. To accommodate potential dropout rates, a total of 64 children were allocated for participation.[12]

The sample comprised children aged 4-12 years with spastic diplegic CP having a Modified Ashworth Scale (MAS) score of 2-3, appropriate bone health for mobilisation, who were receiving standard PT treatments with adequate cognitive abilities. Those with MAS scores 1 or 4, Gross Motor Function Classification System (GMFCS) score III or higher, recent orthopaedic surgery, botox treatments within the preceding 3 months, and full ankle dorsiflexion (DF) were excluded.[12,13]

The enrolled subjects were randomised using online Graph Pad software into intervention group IG and control group CG after taking informed consent from the parents. It was ensured that the groups were comparable in terms of age, height and weight.

All participants performed 5 sets of functional activities each repeated 3 times a day for 3 days per week for 4 weeks. These sets were: sit-to-stand, stand-to-sit, squat, stair stepping, and bridging. The therapist used a wooden step 60 cm long x 45 cm wide x 15 cm high, and no handrail was used. All the subjects received regular PT sessions, overseen by their parents, while those in group IG additionally received functional Mulligan's mobilisation with movement (MWM) technique consisted of gliding and resting while the child was performing the functional sets. Each gliding involved 10s of posterior talar glide with DF and 5s of resting between the gliding. For the gliding, grade III movements were used. The therapist applied a sustained posteroanterior (PA) glide to the tibia through the belt by leaning backward, while the talus and forefoot were fixed in the space between the thumb and the second finger of the right hand. The other hand was positioned anteriorly over the proximal tibia to direct the knee over the line of the second and third toes. Then the participant was instructed to perform a slow DF movement until the first onset of pain or end of ROM without the heel lifting off the ground.

The conventional PT provided to participants in both the groups included gentle stretching exercises to improve muscle flexibility, targetted muscle strengthening routines, activities focussing on balance and coordination, gait training for walking improvement, and task-specific functional activities. Core strengthening exercises, mobility training and, if necessary, assistance with mobility aids or orthotic devices were integrated based on individual requirements. Monitoring baseline and post-intervention assessments were conducted by another physiotherapist for blinding. Blinding procedures were implemented to minimise bias in the study. Physical therapists responsible for administering MWM treatment were different from those involved in outcome assessments. The therapists delivering the MWM intervention were not informed about the control group's activities, and were asked to avoid any communication that might reveal the nature of the intervention to the participants. Outcome assessments were performed by an assessor who was blinded to the participants' group assignments. The assessor was not involved in the delivery of interventions and was kept unaware of the specifics of the treatment received by each participant. The assessments were conducted in a different room from the one where MWM was applied. The subjects were not taken to any treatment session on assessment days. Although the participants were clearly informed about the study, they were asked not to mention on their groups to anybody else from the researcher. It was important to make assessor blind to the groups. Regular communication among therapists, assessor, and participants was minimised to prevent inadvertent unblinding. In cases where communication was necessary, strict instructions were followed to avoid revealing the details that could compromise blinding. Data collected during the study, including baseline and post-intervention assessments, were coded without reference to group assignments. The statistical analysis was conducted by a separate team member who was unaware of group allocations.

ROM of ankle active and passive DF was measured using a universal goniometer. This method is considered reliable for assessing ROM in spastic children with CP.[14] Dynamic balance was assessed using the timed up and go (TUG) test, which measures the time taken for a person to complete a set of movements from sitting to standing, walking, turning and returning to sitting. A shorter time indicated better balance. The TUG test is considered reliable for certain GMFCS levels.[15]

Gross motor function measure (GMFM) assesses various dimensions of motor function.[16] The 88-item GMFM version showed good reliability and construct validity.[15] The 6-minute walk test (6MWT) measured the distance that children could walk in 6 minutes, and it has been shown to be reliable.[17] The Cerebral Palsy Quality of Life (CPQOL)questionnaire for children was used to assess various aspects of children's quality of life (QOL), including social acceptability, wellbeing, involvement, physical health, emotional and mental health, among others.[18] The scores were transformed into a scale ranging 0-100, with higher scores indicating better QOL.

Data was analysed using SPSS 24. Data was presented using the Consolidated Standards of Reporting Trials (CONSORT) checklist.[19] Descriptive statistics, independent-samples t-tests, and analysis of covariance (ANCOVA) were employed to examine intragroup and intergroup difference between baseline and post-intervention values. P<0.05 was considered significant.

Results

Of the 64 patients, 32(50%) were in each of the two groups (Figure). There were 40(63%) girls and 24(37%) boys, and there were no significant difference between the groups with respect to age, weight and height (Table 1). No adverse events or contraindications were observed during the intervention. Families reported some fatigue from prolonged assessments, but this was not considered adverse.

Ankle MWM significantly affected ROM of both ankles (*p*=0.000), and significantly improved children's balance (*p*=0.041), but had no significant impact on gait (*p*=0.266). It had a significant positive effect on gross motor function (*p*=0.000) and QOL (*p*=0.001) of the children with spastic CP (Table 2).

Table-1: Intergroup comparison of demographic data.

Variables	IG Mean±SD	CG Mean±SD	*t*-test	*p*-value
Mean Age (years)	8.3±2.3	8.0±2.3	-0.441	0.661
Weight (kg)	26.8±8.5	26.3±9.5	-0.208	0.836
Height (cm)	117.8±17.1	113.6±17.9	-0.964	0.339

IG: Intervention group; CG: Control group; SD; Standard deviation.

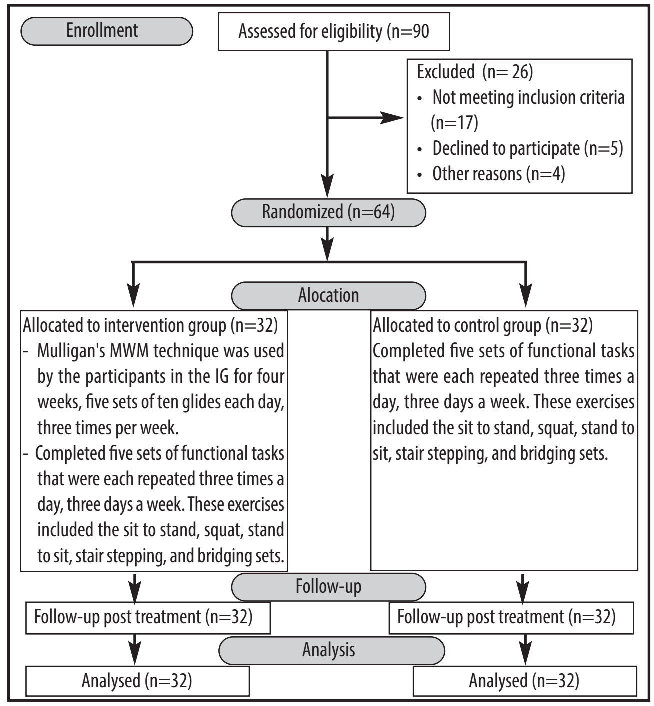

Figure: The study flow-chart.

Table-2: Intergroup comparison at baseline and post-intervention.

Group/Variable	Pre Right Ankle DF Active ROM	Post Right Ankle DF Active ROM	Pre Left Ankle DF Active ROM	Post Left Ankle DF Active ROM
Control	9.2±2.6	9.3±2.6	9.2±2.6	9.3±2.6
Intervention	8.4±1.5	9.1±1.7	8.4±1.5	9.1±1.7
Sig (ANCOVA)	0.000		0.000	
Group/Variable	**Pre Right Ankle DF Passive ROM**	**Post Right Ankle DF Passive ROM**	**Pre Left Ankle DF Passive ROM**	**Post Right Ankle DF Passive ROM**
Control	10.2±3.1	10.7±3.4	10.2±3.1	10.7±3.4
Intervention	9.4±2	10.5±2.7	9.4±2	10.5±2.7
Sig (ANCOVA)	0.000		0.000	
Group/Variable	**Pre TUG in Seconds**	**Post TUG in Seconds**	**Pre 6 Min Walking Test**	**Post 6 Min Walking Test**
Control	10.7±1.4	10.1±1.5	339.8±99.8	350.1±101.2
Intervention	10.2±2	9.3±1.7	353±107.9	366.4±106.5
Sig (ANCOVA)	0.041		0.266	
Group/Variable	**Pre GMFM 88**	**Post GMFM 88**	**Pre Quality of Life**	**Post Quality of Life**
Control	67.6±16.4	67.8±16.4	3382.9±373.5	2378.9±658.8
Intervention	69.6±14.3	72.6±13.5	2906.6±264.9	3218.8±256.9
Sig (ANCOVA)	0.000		0.001	

IG: Intervention group; CG: Control group; DF: Dorsiflexion; ROM: Range of motion; ANCOVA: Analysis of covariance; TUG: Timed up and go test; GMFM: Gross motor function measure.

Discussion

The current study revealed that ankle joint mobilisation significantly improved active and passive ankle ROM, balance and GMFM in children with spastic diplegic CP, but it did not significantly impact gait performance or immediately influenced QOL. These findings underlined the importance of ankle joint mobilisation as a valuable rehabilitation technique for children with CP.[20] The current study held a unique advantage as it marked one of the first instances where the Mulligan technique was applied to ankle joints as a manual treatment approach, comprehensively assessing its effects across all ICF dimensions for children with CP.

MWM reduced soleus muscle stiffness and restore ankle joint flexibility.[19] Other studies in adult stroke survivors and chronic stroke patients reported improvements in ankle ROM and strength with MWM.[21,22] Similarly, the current study demonstrated that MWM significantly improved both active and passive ankle ROM in children with spastic diplegic CP. Thus, MWM can be considered a beneficial intervention for improving ankle mobility in children with CP.

As expected, the improved ROM was associated with enhanced balance, as measured by TUG test. This improvement could be attributed to better joint range and biomechanics, which can enhance joint proprioception which is a crucial component of balance. Additionally, improved joint range allowed for more effective postural reactions to changes in balance and centre of gravity, contributing to improved balance.[23,24]

The GMFM improved in the current study. CP primarily hinders gross motor function, impacting daily activities.[25,26] Improved gross motor function is essential for children with CP, and the current results suggested that ankle MWM contributed to this improvement. Although gait improvement is often expected with ROM and balance improvements, the current study did not find a significant impact on gait performance. This may be related to the type of CP since diplegic children have severe ambulation problems and resistance to have a change in gait. Thus, long-term mobilisation may be investigated to see the progression in gait of CP children.

The current study also examined the impact of ankle MWM on QOL of children with CP. The data in this study indicated that the quality of life of the participants of both groups decreased in the post-assessment, which shouldn't be the case. However, the decrease in CG was higher than the decrease in IG. Still, according to the data, there was a significant effect of the application of the Mulligan technique on the ankles of children with CP on their QOL. This unexpected result could be due to the time required for improvements in functional aspects, such as balance and gait, to manifest their effects on social experiences and overall QOL. Long-term investigations are needed to assess the actual impact of such intervention on QOL.

The current study has limitations as it did not take into account the diverse cognitive levels and motivations of children with CP. Also, it had a short intervention period when a longer period might have yielded different results, particularly in terms of gait improvement and QOL. Besides, the study did not have a long-term follow-up to assess whether the observed improvements in ankle ROM, balance and gross motor function were sustained over time.

On the basis of the current findings, however, integration of MWM within the functional-oriented intervention in children with CP is recommended. Considering the use of MWM techniques alongside traditional PT when planning the management of children with CP should be encouraged. Studies with long-term follow-up assessments are needed to have a better understanding of such interventions.

Conclusion

Mobilisation with movement had a significant impact on active and passive ankle range of motion, balance and quality of life in diplegic children with cerebral palsy, but it had no impact on gait function.

Acknowledgement: We are grateful to family and friends for support and encouragement.

Disclaimer: None.

Conflict of Interest: None.

Source of Funding: None.

References

1. Wang J, Shi W, Khiati D, Shi B, Shi X, Luo D, et al. Acupuncture treatment on the motor area of the scalp for motor dysfunction in children with cerebral palsy: study protocol for a multicenter randomized controlled trial. Trials. 2020; 21:29. doi: 10.1186/s13063-019-3986-z.
2. Howard JJ, Herzog W. Skeletal Muscle in Cerebral Palsy: From Belly to Myofibril. Front Neurol. 2021; 12:620852. doi: 10.3389/fneur.2021.620852.
3. Shetty T, Parab S, Ganesan S, Agarwal BM, Mullerpatan R. Lower extremity muscle strength and endurance in ambulatory children with cerebral palsy. Crit Rev Phys Rehab Med. 2019; 31:75-84. DOI: 10.1615/CritRevPhysRehabilMed.2019029963
4. Saifee S, Kovela RK. Research Protocol of NDT-Bobath and Proprioceptive Neuromuscular Facilitation Vs Proprioceptive Neuromuscular Facilitation Alone, to Improve Trunk Control, Balance, and Gait Parameters in Post-Stroke Patients–A Randomized Clinical Trial. J Pharm Res Int. 2022; 34:25-32. DOI: 10.9734/jpri/2022/v34i1B35350
5. Conner BC, Remec NM, Michaels CM, Wallace CW, Andrisevic E, Lerner ZF. Relationship between ankle function and walking ability for children and young adults with cerebral palsy: A systematic review of deficits and targeted interventions. Gait Posture. 2022; 91:165-78. doi: 10.1016/j.gaitpost.2021.10.024.
6. Farajzadeh A, Maroufizadeh S, Amini M. Factors associated with quality of life among mothers of children with cerebral palsy. Int J Nurs Pract. 2020; 26:e12811. doi: 10.1111/ijn.12811.
7. Ahmadizadeh Z, Khalili MA, Ghalam MS, Mokhlesin M. Effect of whole-body vibration with stretching exercise on active and passive range of motion in lower extremities in children with cerebral palsy:

A randomized clinical trial. J Iran J Pediatrics. 2019; 29: e84436. doi.org/10.5812/ijp.84436

8. Smith MD, Vitharana TN, Wallis GM, Vicenzino B. Response profile of fibular repositioning tape on ankle osteokinematics, arthrokinematics, perceived stability and confidence in chronic ankle instability. Musculoskelet Sci Pract. 2020; 50:102272. doi: 10.1016/j.msksp.2020.102272.
9. Cho KH, Park SJ. Effects of joint mobilisation and stretching on the range of motion for the ankle joint and spatiotemporal gait variables in stroke patients. J Stroke Cerebrovasc Dis. 2020; 29:104933. doi: 10.1016/j.jstrokecerebrovasdis.2020.104933.
10. Park D, Lee JH, Kang TW, Cynn HS. Four-week training involving ankle mobilisation with movement versus static muscle stretching in patients with chronic stroke: a randomized controlled trial. Top Stroke Rehabil. 2019; 26:81-6 doi: 10.1080/10749357.2018.1550614.
11. World Health Organization. International Classification of Functioning, Disability and Health (ICF). Geneva: World Health Organization, 2001.
12. Faul F, Erdfelder E, Lang AG, Buchner A. G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. Behav Res Method. 2007; 39: 175-91. doi.org/10.3758/BF03193146.
13. Rosdiana I, Ariestiani A. The Correlation between Gross Motor Function Classification System and Spasticity in Children with Cerebral Palsy. J Adv Multidisciplin Res. 2021; 2: 70-77.
14. Kim DH, An DH, Yoo WG. Validity and reliability of ankle dorsiflexion measures in children with cerebral palsy. J Back Musculoskelet Rehabil. 2018; 31:465-8. doi: 10.3233/BMR-170862.
15. Youn PS, Cho KH, Park SJ. Changes in Ankle Range of Motion, Gait Function, and Standing Balance in Children with Bilateral Spastic Cerebral Palsy after Ankle Mobilization by Manual Therapy. Children (Basel). 2020; 7:142. doi: 10.3390/children7090142.
16. Noble JJ, Gough M, Shortland AP. Selective motor control and gross motor function in bilateral spastic cerebral palsy. Dev Med Child Neurol. 2019; 61:57-61. doi: 10.1016/j.gaitpost.2018.09.020.
17. Decavel P, Moulin T, Sagawa Y Jr. Gait tests in multiple sclerosis: Reliability and cut-off values. Gait Posture. 2019; 67:37-42. doi: 10.1016/j.gaitpost.2018.09.020.
18. El-Weshahi HM, Mohamed MK, Abd-Elghany HM, Omar TE, Azzawi AE. Psychometric properties of a translated Arabic version of cerebral palsy-quality of life questionnaire: primary caregiver form. Alexandria J Pediatr. 2017; 30:53. DOI:10.4103/AJOP.AJOP_15_17
19. Schulz KF, Altman DG, Moher D. CONSORT 2010 Statement: updated guidelines for reporting parallel group randomised trials. J Pharmacol Pharmacother. 2010; 1:100-7.doi: 10.4103/0976-500X.72352.
20. Sah AK, Balaji GK, Agrahara S. Effects of Task-oriented Activities Based on Neurodevelopmental Therapy Principles on Trunk Control, Balance, and Gross Motor Function in Children with Spastic Diplegic Cerebral Palsy: A Single-blinded Randomized Clinical Trial. J Pediatr Neurosci. 2019; 14:120-6. doi: 10.4103/jpn.JPN_35_19.
21. Park D, Cynn HS. Effects of walking with talus-stabilizing taping on passive range of motion, timed up and go, temporal parameters of gait, and fall risk in individuals with chronic stroke: a cross-sectional study. J Manipulative Physical Therapy. 2021; 44:49-55. doi: 10.1016/j.jmpt.2020.07.007.
22. Kim SL, Lee BH. Effect of Mulligan's Mobilisation with Movement Technique on Gait Function in Stroke Patients. J Phys Ther Sci. 2016; 28:2326-9. doi: 10.1589/jpts.28.2326.
23. Tufekcioglu E, Konukman F, Kaya F, Arslan D, Ozan G, Erzeybek MS, et al. The Effects of Aquatic Watsu Therapy on Gross Motor Performance and Quality of Life for Children with Cerebral Palsy. Montenegr J Sports Sci Med. 2021;10: 1-6.
24. An CM, Jo SO. Effects of talocrural mobilisation with movement on ankle strength, mobility, and weight-bearing ability in hemiplegic patients with chronic stroke: a randomized controlled trial. J Stroke Cerebrovasc Dis. 2017; 26:169-76. doi: 10.1016/j.jstrokecerebrovasdis.2016.09.005.
25. Balzer J, Marsico P, Mitteregger E, van der Linden ML, Mercer TH, van Hedel HJ. Influence of trunk control and lower extremity impairments on gait capacity in children with cerebral palsy. Disabil Rehabil. 2018; 40:3164-70. doi: 10.1080/09638288.2017.1380719.
26. Hernández-Guillén D, Roig-Casasús S, Tolsada-Velasco C, García-Gomáriz C, Blasco JM. Talus mobilisation-based manual therapy is effective for restoring range of motion and enhancing balance in older adults with limited ankle mobility: A randomized controlled trial. Gait Posture. 2022; 93:14-19. doi: 10.1016/j.gaitpost.2022.01.005

Author Contribution:

RSRA: Concept, design, data acquisition, analysis, interpretation, drafting and accountable author for all aspects of the work.
ZGT, ANT: Supervision, revision, final approval.
AA: Editing, data collection and analysis.
AAA: Editing, data acquisition and interpretation.