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

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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.

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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

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

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).

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.

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.

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. 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.

Gross motor function measure (GMFM) assesses various dimensions of motor function. The 88-item GMFM version showed good reliability and construct validity. The 6-minute walk test (6MWT) measured the distance that children could walk in 6 minutes, and it has been shown to be reliable. 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. 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. 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).

**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 underline the importance of ankle joint mobilisation as a valuable rehabilitation technique for children with CP. 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.

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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.