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WEDGE STRETCHING OF HAMSTRING IN DIPLEGIC CEREBRAL PALSY

Original Research

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Acknowledgement: The authors extend their gratitude to the Pakistan Society for Rehabilitation of Disabled, Lahore, for their support in data collection.

Conflict of Interest: None

Grant Support & Financial Support: None

ABSTRACT

Background: Hamstring tightness in diplegic cerebral palsy significantly impacts mobility, leading to difficulties in walking and posture control. Spasticity-induced contractures restrict knee extension, exacerbating movement limitations. Various physiotherapeutic interventions aim to improve muscle flexibility and functional mobility. Wedge stretching is a promising technique designed to facilitate prolonged hamstring elongation, reduce spasticity, and enhance range of motion (ROM). This study assesses the efficacy of sustained hamstring stretching using wedge standing in improving knee function in children with diplegic cerebral palsy.

Objective: To evaluate the effect of sustained hamstring stretching on wedge standing for hamstring contractures and knee ROM in children with diplegic cerebral palsy.

Methods: A quasi-experimental study was conducted on 57 diplegic spastic cerebral palsy patients at the Pakistan Society for Rehabilitation of Disabled, Lahore. Participants were selected through non-probability convenience sampling. Inclusion criteria comprised children aged 3–8 years, classified as GMFCS Level III, with grade III spasticity on the Modified Ashworth Scale. Patients with uncontrolled seizures, significant visual impairments, or other forms of cerebral palsy were excluded. The Knee Orthopedic Score was used for assessment. The intervention involved wedge stretching three times per week for 20 minutes per session over the study duration (March to October 2024). Pre- and post-intervention scores were analyzed using SPSS version 22.

Results: Pre-intervention, 77.2% of patients were classified as having poor knee function, while 13% had good function. None of the patients scored in the fair or excellent categories. Post-intervention, 17.5% of patients remained in the poor category, 15.8% improved to fair, 12.3% reached good, and 54.4% achieved excellent knee function. Pain-free patients increased from 0% to 14%, while moderate continual pain was eliminated. Knee flexion contractures in the 50-100° range increased from 10.6% to 54.3%, and extension lag improved significantly, with 66.7% achieving <100° lag compared to 22.8% pre-intervention. A statistically significant improvement in knee function was observed ($p = 0.000$).

Conclusion: Wedge stretching is an effective intervention for improving knee function, reducing pain, and enhancing range of motion in children with diplegic cerebral palsy. The statistically significant improvements in knee extension highlight its potential as a complementary physiotherapeutic approach for spasticity management.

Keywords: Cerebral palsy, Diplegia, Hamstring, Knee function, Range of motion, Spasticity, Stretching.

INTRODUCTION

Cerebral palsy (CP) is a non-progressive neurological disorder that affects movement and posture due to disturbances in the developing fetal or infant brain. It remains the leading cause of physical disability in children in industrialized countries, with an incidence of 2.0 to 2.5 per 1000 live births (1). This motor impairment is often accompanied by sensory, cognitive, communication, and behavioral difficulties, making it a complex condition with significant functional limitations (2). Rather than being a singular disorder, CP represents a heterogeneous group of syndromes characterized by abnormal motor patterns and postural instability (3). Among the various motor presentations, spastic paresis is the most prevalent, defined by movement-dependent increased muscle tone, which varies in severity based on the affected musculature and biomechanical properties of muscles and connective tissue (4,5). Children with spastic diplegia, a subtype of CP, frequently present with a characteristic posture, including plantar flexion at the ankles, hip medial rotation, and adduction, leading to a narrow base of support (6). This posture increases postural instability, making balance maintenance and movement coordination more challenging. The biomechanics of the lower limbs play a crucial role in gait and mobility, with the hamstrings, gastrocnemius, and rectus femoris acting as primary contributors to knee joint function (7). While it was traditionally believed that hamstring spasticity was the primary cause of crouch gait in CP, recent evidence suggests that hamstring length is often within normal limits; instead, increased pelvic tilt contributes to hamstring contracture and gait abnormalities (8). Given the multifactorial nature of CP-related mobility impairments, therapeutic interventions must address multiple levels of dysfunction rather than focusing solely on individual joints or muscles (9).

Cerebral palsy is frequently associated with knee abnormalities such as crouch gait, stiff knee gait, flexion deformities, and femoropatellar malalignment, all of which contribute to functional limitations (10). In diplegic CP, hypertonicity and spasticity primarily affect the lower limbs, leading to restricted knee extension, impaired gait mechanics, and reduced overall mobility (11). One promising therapeutic approach for improving hamstring flexibility and functional movement in children with diplegic CP is wedge stretching. This technique involves positioning the patient on an inclined surface to passively or actively stretch the hamstring muscles, promoting muscle-tendon elongation while reducing spasticity (12). By maintaining an extended knee position on a wedge, individuals with CP can achieve prolonged stretching, which may facilitate neuromuscular adaptations that enhance postural control and gait performance. Regular incorporation of wedge stretching into physiotherapy regimens has the potential to optimize lower limb function, prevent muscle contractures, and improve overall quality of life in children with CP (13). Despite its clinical promise, limited research has explored the optimal frequency and duration of wedge stretching necessary for achieving long-term benefits. Existing studies on CP prevalence indicate a global variation, with estimates ranging from 1.5 to more than 4 per 1000 live births (14). In Pakistan, a study analyzing 160 CP cases reported that approximately 70-75% of affected individuals exhibited disturbances in muscle tone, motor function, and posture (15). The underlying etiology of CP varies, encompassing prenatal, perinatal, and early postnatal brain injuries, with spastic CP accounting for nearly 90% of cases (16). Within this category, bilateral spastic CP involves hypertonicity affecting both upper and lower limbs, leading to common secondary deformities such as equinus foot positioning, which exacerbates gait difficulties and increases the risk of falls, injuries, and orthopedic complications (17).

In clinical rehabilitation, static weight-bearing exercises are commonly employed to prevent soft tissue contractures and restore muscle length through prolonged stretching (18). These exercises, including standing table positioning, are believed to mitigate spasticity by modulating neuromuscular excitability via muscle spindle and Golgi tendon organ activation (19). However, comprehensive CP rehabilitation extends beyond physical interventions, encompassing efforts to enhance mobility, fine motor skills, self-care, and overall functional independence (20). The management of CP requires a multidisciplinary approach that integrates therapeutic strategies with psychosocial support for both the child and their caregivers (21). Given the significant impact of hamstring tightness on gait and mobility in children with diplegic CP, this study aims to evaluate the effectiveness of wedge stretching as a therapeutic intervention. By investigating its role in improving hamstring flexibility, reducing spasticity, and enhancing functional movement, this research seeks to provide evidence-based insights that can contribute to optimizing rehabilitation strategies for children with CP.

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METHODS

A quasi-experimental study was conducted to evaluate the effects of wedge stretching on hamstring flexibility in children diagnosed with diplegic spastic cerebral palsy. A total of 57 patients aged between 3 to 8 years were recruited based on specific inclusion and exclusion criteria. The study included children with a confirmed diagnosis of diplegic spastic cerebral palsy, classified as Level III on the Gross Motor Function Classification System (GMFCS), exhibiting spasticity graded as III on the Modified Ashworth Scale. Additionally, participants were required to have the cognitive ability to follow commands and instructions, as well as documented lower limb impairment diagnosed by a medical practitioner. Children presenting with uncontrolled seizures, significant visual impairments that could interfere with the intervention, or any other type of cerebral palsy were excluded from participation. Written informed consent was obtained from the parents or legal guardians of all participants before their enrollment in the study, ensuring compliance with ethical guidelines. Ethical approval was secured from the institutional review board. All procedures were conducted following ethical principles for research involving human subjects, maintaining confidentiality and the right to withdraw at any stage without consequences.

Data collection involved the use of standardized assessment tools, including a goniometer for measuring joint range of motion and the Knee Orthopedic Score for functional evaluation. The study was conducted over a period from March 2024 to October 2024. The intervention and assessments were administered in a controlled clinical setting, ensuring standardized conditions for all participants. Statistical analysis was performed using SPSS version 22. Descriptive statistics were employed to summarize baseline characteristics, while inferential tests were applied to determine the significance of changes observed following the intervention. All analyses adhered to appropriate statistical methodologies, with a predetermined level of significance to validate the findings.

The intervention protocol involved supervised wedge stretching sessions conducted three times per week over the study duration. Each session lasted 20 minutes, during which participants were positioned on an inclined wedge to facilitate passive or assisted hamstring stretching while maintaining knee extension. The incline angle was standardized at 15 degrees, ensuring a controlled and progressive stretch without inducing discomfort. Stretching intensity was adjusted based on individual tolerance, with careful monitoring of muscle response and spasticity levels. Participants' progress was evaluated using goniometric measurements of knee extension and Knee Orthopedic Score assessments, ensuring objective tracking of improvements in muscle flexibility and functional movement. Any signs of excessive discomfort or increased spasticity prompted necessary modifications to optimize therapeutic benefits.

RESULTS

The study evaluated the impact of wedge stretching on knee extension, flexion contractures, extension lag, total knee flexion range, and knee alignment in children with diplegic spastic cerebral palsy. Pain assessment was the first parameter analyzed, where pre-intervention results indicated that all patients experienced some degree of pain. Among them, 70.2% reported mild pain, categorized as occasional pain (10.5%), pain while climbing stairs (12.3%), and pain during both walking and stair climbing (47.4%). Moderate pain was noted in 29.8% of patients, classified as moderate occasional (15.8%) and moderate continual (14.0%). Post-intervention, 14% of patients reported being completely pain-free, with mild pain still persisting in 68.5% and moderate pain reducing to 17.5%. Notably, no patients experienced moderate continual pain after treatment. Flexion contracture, categorized into four severity ranges, showed significant improvement. Initially, 10.6% of patients had knee flexion within 50-100 degrees, 59.6% in the 100-150-degree range, and 29.8% in the 160-200-degree range. Post-intervention, a notable shift was observed, with 54.3% of patients improving to the 50-100-degree range, 28.2% in the 100-150-degree range, and 17.5% in the 160-200-degree range. No patients exhibited contractures exceeding 200 degrees in either pre- or post-assessments.

Extension lag analysis revealed that before intervention, 22.8% of patients had knee extension lag of less than 100 degrees, 63.2% were within the 100-200-degree range, and 14% had an extension lag exceeding 200 degrees. Post-intervention results demonstrated a substantial improvement, with 66.7% of patients falling below 100 degrees, 33.3% within the 100-200-degree range, and no cases exceeding 200 degrees. Total knee flexion was categorized into five ranges. Before the intervention, 14% of patients had knee flexion between 51-75 degrees, 63.2% between 76-100 degrees, and 22.8% between 101-125 degrees. Post-intervention, 17.5% of patients showed improvement within the 51-75-degree range, 57.9% in the 76-100-degree range, and 24.6% in the 101-125-degree range. No patients had flexion below 51 degrees in either phase.

Knee alignment assessment indicated that before the intervention, 59.6% of patients fell within the 0-40-degree range and 40.4% in the 110-150-degree range, while none were in the 50-100-degree or >150-degree categories. Post-intervention, 70.2% of patients improved

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to the 0-40-degree range, 14% fell within the 50-100-degree range, and 15.8% remained within the 110-150-degree range. No patients exceeded 150 degrees of misalignment. Knee function scores were assessed using a t-test. The mean pre-intervention knee function score was 57.9±16.6, which significantly improved to 73.4±17.9 post-intervention. A statistically significant difference was observed, with a p-value of 0.000 (≤0.05), confirming the effectiveness of the wedge stretching intervention.

Table 1: Pain Assessment in Diplegic Cerebral Palsy Patients (Pre and Post-Intervention)

Pain	**Pre(%)**	**Post (%)**
None	0 (0)	8 (14.0)
Mild/Occasional	6 (10.5)	6 (10.5)
Mild (Stairs Only)	7 (12.3)	17 (29.8)
Mild (Walking and Stairs)	27 (47.4)	16 (28.2)
Moderate-Occasional	9 (15.8)	10 (17.5)
Moderate-Continual	8 (14.0)	0 (0)
Severe	0 (0)	0 (0)
Total	57 (100)	57 (100)

Table 2: Knee Flexion Contracture, Extension Lag, and Alignment Changes (Pre and Post-Intervention)

	Pre n (%)	**Post n (%)**
Flexion Contracture		
50-100	6 (10.6)	31(54.3)
100-150	34 (59.6)	16 (28.2)
160-200	17 (29.8)	10 (17.5)
>200	0 (0)	0 (0)
Total	57 (100)	57 (100)
Extension lag		
<100	13 (22.8)	38 (66.7)
100-200	36 (63.2)	19 (33.3)
>200	8(14.0)	0 (0)
Total range of knee flexion		
0-25	0 (0)	0 (0)
26-50	0 (0)	0 (0)
51-75	8 (14.0)	10 (17.5)
76-100	36 (63.2)	33 (57.9)
101-125	13 (22.8)	14 (24.6)

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Alignment	Pre n (%)	Post n (%)
00-40	34 (59.6)	40 (70.2)
50-100	0 (0)	8 (14.0)
110-150	23 (40.4)	9 (15.8)
>150	0 (0)	0 (0)

Table 3: Knee Function Score Comparison Before and After Wedge Stretching Intervention

Knee Function Score	n	Mean+ sd	t	df	p-value
Pre	57	57.9+16.6			
Post	57	73.4+17.9	-4.851	56	0.000

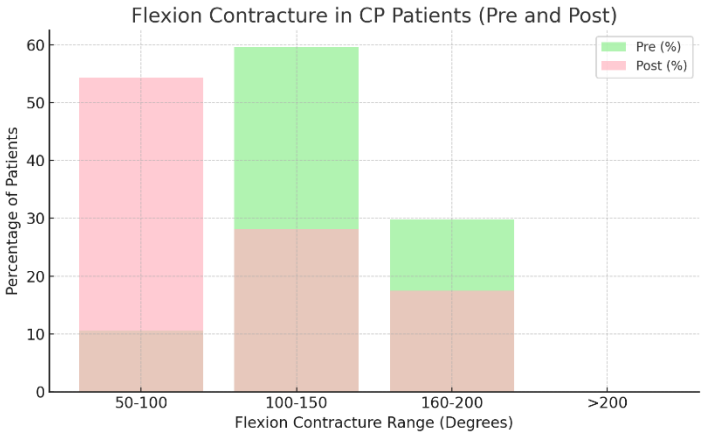

Figure 2 Flexion Contracture in CP Patients

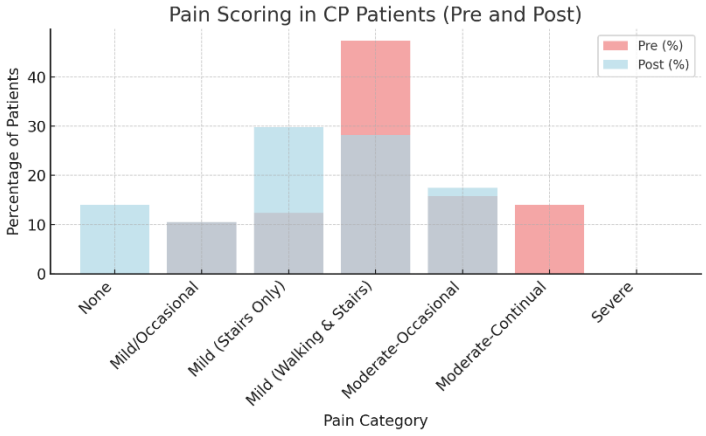

Figure 1 Pain Scoring in CP Patients

DISCUSSION

The findings of this study demonstrate the beneficial effects of sustained hamstring stretching using wedge standing on hamstring contractures and knee range of motion (ROM) in children with diplegic cerebral palsy. The significant improvements in knee extension, pain reduction, and functional knee scores suggest that this intervention can play a vital role in enhancing mobility and reducing musculoskeletal complications associated with spasticity. The hypothesis that sustained hamstring stretching through wedge standing would improve knee extension in diplegic cerebral palsy was supported by the results, which align with prior research emphasizing the efficacy of prolonged stretching techniques in managing spastic hypertonicity (12). Pain assessment, a critical component of knee extension evaluation, revealed that almost all patients experienced some degree of pain before the intervention. Post-intervention results demonstrated that 14% of patients became pain-free, with a noticeable reduction in moderate pain levels. These outcomes align with previous studies indicating that sustained stretching can alleviate musculoskeletal pain by promoting muscle elongation and reducing spasticity-related discomfort. The observed improvement in pain levels may be attributed to the neuromodulatory effects of prolonged stretching, which contribute to decreased excitability of motor neurons and enhanced tissue compliance (14).

Knee function scores significantly improved following the intervention, as evident from the shift in classification from predominantly poor pre-intervention scores to a majority of patients achieving excellent knee function post-intervention. These findings support the notion that sustained hamstring stretching enhances functional mobility and reduces the restrictive effects of hypertonicity on gait and posture. The results are consistent with prior studies indicating that structured physiotherapeutic interventions targeting lower limb

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spasticity lead to meaningful improvements in motor performance and independence in activities of daily living (15). Flexion contracture assessments revealed notable improvements in knee flexion angles, with a considerable proportion of patients transitioning to lower severity categories post-intervention. The reduction in contracture severity suggests that sustained hamstring stretching contributes to biomechanical adaptations that enhance joint mobility and muscle extensibility. The findings are in accordance with prior research highlighting the role of sustained stretching in mitigating contractures and improving overall lower limb alignment in children with cerebral palsy. However, while the observed improvements are promising, the extent to which these gains are maintained over the long term remains uncertain. Future research should focus on evaluating the durability of these effects and determining the optimal frequency and duration of stretching interventions for sustained benefits (16,18).

Despite the strengths of this study, including its structured intervention protocol and objective assessment measures, certain limitations should be acknowledged. The relatively short follow-up period restricts conclusions regarding long-term functional outcomes. Additionally, the study did not incorporate a control group, which would have provided a more robust comparison of the intervention's efficacy. The reliance on clinical assessment tools, while valuable, may have introduced subjective biases in pain and function scoring. Future studies should consider incorporating objective biomechanical analysis, such as gait assessment using motion capture technology, to further validate the effects of wedge stretching on lower limb function (20). The findings contribute to the growing body of evidence supporting the role of targeted physiotherapeutic interventions in managing spasticity-related impairments in cerebral palsy. The observed improvements in knee ROM, pain levels, and functional mobility highlight the clinical relevance of sustained hamstring stretching in rehabilitation programs. However, further studies are warranted to explore individualized intervention protocols, long-term adherence, and the potential integration of wedge stretching with other physiotherapeutic modalities for comprehensive management.

CONCLUSION

This study demonstrated that sustained hamstring stretching through wedge standing is an effective intervention for improving knee extension, reducing contractures, and enhancing functional mobility in children with diplegic cerebral palsy. The findings highlight the therapeutic potential of prolonged stretching in alleviating muscle tightness and improving range of motion, ultimately contributing to better posture and movement efficiency. The observed improvements in knee function suggest that integrating this technique into rehabilitation programs can offer meaningful benefits in managing spasticity-related impairments. These results reinforce the importance of structured physiotherapeutic interventions in optimizing mobility and enhancing the quality of life for individuals with cerebral palsy.

AUTHOR CONTRIBUTIONS

Author	Contribution
Ghousia Iftikhar	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Nayab Naveed	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing Has given Final Approval of the version to be published
Syed Saqlain Babar	Substantial Contribution to acquisition and interpretation of Data Has given Final Approval of the version to be published
Zarish Younas4*	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Samia Khaliq	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Tasmiah Manzoor	Substantial Contribution to study design and Data Analysis Has given Final Approval of the version to be published
Muhammad Usama Ishfaq	Contributed to study concept and Data collection Has given Final Approval of the version to be published

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