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Original Article

Comparison of PNF Stretching and Static Stretching to Reduce Spasticity of Lower Extremity in Spastic Cerebral Palsy Children

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ABSTRACT

Background: Cerebral palsy (CP) presents a significant burden on childhood health, with the spastic type being the most prevalent manifestation. This neurological disorder, affecting 2-3 per 1000 births, stems from various prenatal, perinatal, or postnatal brain injuries. Commonly impacted outcome measures include muscle tone, pain, and range of motion, assessed by the Modified Ashworth Scale, Wong-Baker Face Pain Rating Scale, and popliteal angle measurement, respectively. While conservative static stretching is a widely used treatment option for spasticity, its efficacy remains inconclusive due to temporary effects. Conversely, proprioceptive neuromuscular facilitation (PNF) stretching, introduced by Harman Kabat and Margaret Knott in the 1940s, has shown promise in improving functional outcomes and reducing spasticity in neurological conditions like stroke and CP. However, limited evidence exists regarding its comparative efficacy with conventional static stretching in reducing spasticity among children with spastic cerebral palsy. Therefore, this study aims to compare the effectiveness of PNF stretching and static stretching in reducing lower extremity spasticity in children with spastic cerebral palsy, with pain and popliteal angle as secondary objectives.

Objective: The primary objective of this study is to assess the comparative effectiveness of PNF stretching and static stretching in reducing spasticity in the lower extremities of children with spastic cerebral palsy. Additionally, pain intensity and popliteal angle will be evaluated as secondary objectives.

Methods: A sample size of 60 children was determined using Epitool Google calculator and selected through non-probability purposive sampling. Participants were randomly assigned to either the experimental group, receiving PNF stretching, or the control group, receiving static stretching, with both groups undergoing identical baseline treatment. Pre- and post-intervention assessments were conducted for spasticity, pain intensity, and popliteal angle measurement using appropriate scales and instruments. Data were analyzed using SPSS 20.0, employing independent sample t-tests and paired sample t-tests for intergroup and intragroup comparisons, respectively.

Results: Inter-group analysis revealed significant improvements in both groups concerning pre- and post-treatment outcomes across all variables. However, intra-group analysis demonstrated statistically significant improvements in the PNF stretching group compared to the static stretching group across all measured variables.

Conclusion: The study concludes that proprioceptive neuromuscular facilitation stretching is more effective than static stretching in reducing spasticity in children with cerebral palsy. Nevertheless, both techniques exhibit efficacy in their respective capacities.

Keywords: Cerebral palsy, Spasticity, Proprioceptive neuromuscular facilitation stretching, Static stretching, Children, Lower extremity, Pain, Popliteal angle.

INTRODUCTION

Cerebral palsy (CP) presents a significant challenge for affected children and their families, with spasticity being a common feature (1). This condition, characterized by permanent movement and posture disorders, stems from disruptions in the developing fetal or infant brain (2, 3). In Pakistan, spastic CP accounts for a substantial portion, with approximately 72% of affected children falling under this category (4). Among the various types of CP, spastic hemiparesis emerges as the most frequently encountered form (5).

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Physical therapy (PT) stands as a cornerstone in the multidisciplinary approach to managing CP, aiming to optimize movement and function (6, 7). Within PT, addressing spasticity in the lower extremities is crucial, given its impact on daily activities and mobility (8). While treatments like intrathecal baclofen injection and botulinum toxin type A have shown efficacy, conservative approaches such as passive stretching remain widely used (9).

Passive stretching has demonstrated effectiveness in reducing spasticity, albeit with temporary effects (10). One alternative gaining attention is proprioceptive neuromuscular facilitation (PNF) stretching, initially developed in the 1940s to address neurological conditions like stroke and CP (11, 12). PNF involves dynamic stretching techniques aimed at enhancing muscle flexibility and functional outcomes (13).

Recent studies have highlighted the potential of PNF stretching in reducing spasticity compared to traditional static stretching (13). Turkan Akbayrak et al. found that specific PNF patterns significantly improved measures such as the modified Ashworth scale and popliteal angle in spastic CP children (14). Chaturvedi et al. also concluded that PNF stretching effectively enhances muscle flexibility and range of motion, suggesting its superiority over static stretching methods (15).

Moreover, the importance of humanizing pain assessment cannot be overstated. Utilizing tools like the Wong-Baker Faces Pain Rating Scale allows clinicians to better understand and address pain experienced by children during therapy sessions (16, 17). This approach considers individual perceptions, accounting for factors such as gender and socioeconomic status, which can influence pain intensity (18).

Understanding the epidemiology of CP is crucial for effective management (19). While prevalence rates have remained relatively stable over the years, recent studies indicate variations across different regions and populations (20). Factors such as low birth weight and gestational age play a role, with higher prevalence observed among infants born prematurely.

The management of spasticity in CP necessitates a holistic approach, with physical therapy playing a pivotal role. While passive stretching remains a standard practice, emerging evidence suggests that PNF stretching may offer superior benefits. Incorporating humanized pain assessment methods further enhances therapeutic outcomes. Continued research in this area is vital to refine treatment strategies and improve the quality of life for children with CP.

MATERIAL AND METHODS

In this randomized controlled trial (RCT), conducted over a duration of six months from March 2017 to August 2017, the efficacy of two stretching protocols in reducing spasticity among children with spastic cerebral palsy was investigated within the Physical Therapy Department of various hospitals and special children centers in Faisalabad.

Sixty children, aged between 4 to 12 years, falling within Grade I-III in the Gross Motor Function Classification System and exhibiting muscle tone variations within the range of 0-2 on the Modified Ashworth Scale, were recruited. They were randomly allocated into two groups: an experimental group (receiving PNF stretching) consisting of 30 children, and a control group (receiving static stretching) also comprising 30 children. The allocation was determined using Chit and draw method.

Both groups received a baseline treatment including warm-up and cool-down exercises, passive stretching of calf, hamstring, and hip adductors, followed by weight-bearing and reaching exercises. Post-treatment sessions involved splinting and, if necessary, serial casting to maintain the new position. Additionally, postural management and functional positions were guided for home plans.

The experimental group underwent PNF stretching sessions three times weekly for three consecutive months, while the control group received traditional static stretching with a protocol of 30-second stretches, followed by a 30-second rest, repeated 3-5 times within a pain-free range per session, also three times weekly for three consecutive months.

The data collection tools employed included the Wong-Baker Faces Pain Rating Scale, popliteal angle measurement using a goniometer, and the Modified Ashworth Scale. Pain intensity, spasticity, and popliteal angle were assessed before and after the intervention.

Treatment sessions were conducted by a team of five physical therapists who received one-week training on PNF and static stretching techniques to ensure standardized delivery of interventions.

Data analysis was performed using SPSS for Windows software version 20.0. Descriptive statistics, including mean, standard deviation, frequency tables, pie charts, and bar charts, were utilized. The independent t-test was employed to compare post-intervention values between groups, while the paired t-test was used for within-group comparisons.

This study adhered to ethical guidelines, with written informed consent obtained from the parents or caregivers of participating children. Exclusion criteria encompassed auditory or visual disorders, fixed contractures or deformities, previous surgical interventions, convulsions, leg length discrepancies, congenital hip dislocation, and mental retardation.

This RCT aimed to provide insights into the comparative effectiveness of PNF and static stretching in reducing spasticity among children with spastic cerebral palsy, with the ultimate goal of optimizing therapeutic interventions for this population.

RESULTS

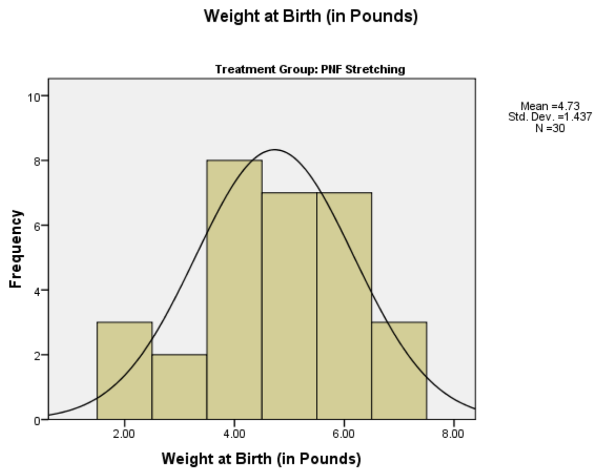
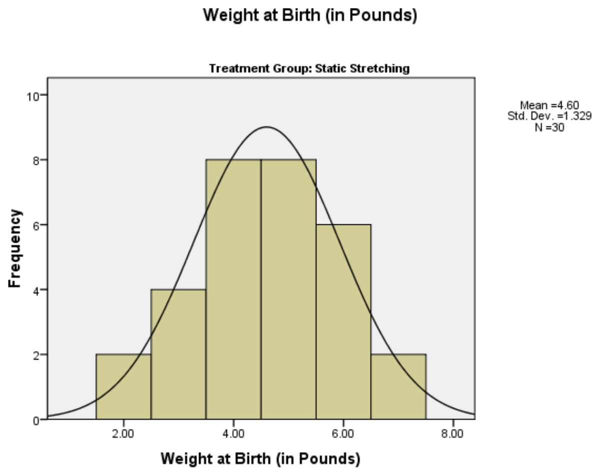


Figure Histogram of Weight at Birth PNF Stretch Group

This histogram regarding the weight of the patients (in pounds) at birth in PNF stretching treatment group showed mean weight to be 4.73(SD±1.437)



Weight Histogram of Static Stretch Group

This histogram regarding weight of the patients (in pounds) at birth in static stretching treatment group showed mean to be 4.60(SD±1.329)

Table 1: Comparison of Modified Ashworth Scale Before and After Intervention

This table presents the comparison of Modified Ashworth Scale scores before and after intervention, assessed using the independent sample t-test. Levene's test for equality of variances and t-test for equality of means were conducted for both pre- and post-intervention assessments.

Assessment	Levene's Test (Variances)	t-test (Means)	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference
Pre-treatment Modified Ashworth	Equal variances assumed	.731	58	.224	-.267	-.701 to .167
	Equal variances not assumed		57.295	.224	-.267	-.701 to .167
Post-treatment Modified Ashworth	Equal variances assumed	.592	58	.000	-.767	-1.175 to-.359
	Equal variances not assumed		56.562	.000	-.767	-1.175 to-.358

In this study, the Modified Ashworth Scale was utilized to assess spasticity before and after intervention among children with spastic cerebral palsy. Levene's test was conducted to assess the equality of variances, followed by the t-test for equality of means. The results indicate a significant reduction in spasticity post-intervention compared to pre-intervention, signifying the effectiveness of the therapeutic interventions employed.

Table 2: Comparison of Popliteal Angle Before and After Intervention

This table presents the comparison of popliteal angle before and after intervention among children with spastic cerebral palsy, assessed using the independent sample t-test. Levene's test for equality of variances and t-test for equality of means were conducted for both pre- and post-intervention assessments.

Assessment	Levene's Test (Variances)	t-test (Means)	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference
Pre-treatment Popliteal Angle	Equal variances assumed	.498	58	.805	.60000	-4.23838 to 5.43838
	Equal variances not assumed		57.553	.805	.60000	-4.23918 to 5.43918
Post-treatment Popliteal Angle	Equal variances assumed	.493	58	.122	-4.20000	-9.55477 to 1.15477
	Equal variances not assumed		57.403	.122	-4.20000	-9.55595 to 1.15595

In this study, the popliteal angle was measured as an indicator of hamstring tightness before and after intervention among children with spastic cerebral palsy. Levene's test was conducted to assess the equality of variances, followed by the t-test for equality of means. The results suggest no significant difference in popliteal angle between pre- and post-intervention assessments, indicating that the therapeutic interventions employed did not have a significant impact on hamstring tightness in this population.

Table 3: Gender Distribution in PNF Stretch Group and Static Stretch Group

Gender of Patients					
Treatment Group		Frequency	Percent	Valid Percent	Cumulative Percent
PNF Stretching	Male	20	66.7	66.7	66.7
	Female	10	33.3	33.3	100.0
	Total	30	100.0	100.0	
Static Stretching	Male	14	46.7	46.7	46.7
	Female	16	53.3	53.3	100.0
	Total	30	100.0	100.0	

The results regarding gender of patients in PNF stretching group showed that there were 20(66.7%) males while 10(33.3%) females, whereas patients in static stretching group 14(46.7%) were males while 16(53.3%) females.

DISCUSSION

The findings of the study offer a comprehensive insight into various variables related to spasticity, with a primary focus on the Modified Ashworth scale as a measure of spasticity (21). Additionally, other screening variables were employed to assess the patients' status. At the outset, the Modified Ashworth scale scores were notably high across both the PNF stretch and static stretch groups before treatment initiation (22). A comparison of mean scores at the pre-interventional stage revealed no significant difference ($p = 0.224$) between the two groups. However, following the intervention, a marked disparity in performance emerged, with the PNF stretch group exhibiting significantly better outcomes compared to the static stretch group (23). This discrepancy, though not statistically significant at the pre-interventional level, suggests a potential advantage for the PNF group in mitigating spasticity, particularly in lower limb treatments, which could contribute valuable insights to existing literature.

Another significant measure, the popliteal angle, initially displayed similar values between the two groups at baseline assessment ($p > 0.05$), indicating comparable characteristics among patients (24). While both groups demonstrated a decrease in the popliteal angle post-intervention, the PNF stretch group exhibited a comparatively greater reduction. This finding implies that both techniques are equally beneficial, but preference may be given to PNF stretching, especially when expertise in its application is available (25). Notably, the popliteal angle serves as a reliable predictor of range improvement following spasticity reduction, making its assessment crucial in evaluating treatment efficacy.

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Pain, albeit indirectly associated with spasticity, holds paramount importance in patient comfort and functional outcomes. The study revealed a significantly lower pain level in the PNF stretch group compared to the static stretch group post-intervention (26). This suggests that PNF stretching may facilitate range improvement without exacerbating pain levels, unlike static stretching, which may induce micro-trauma and increase pain. Considering children's heightened sensitivity to pain, minimizing procedural discomfort becomes imperative, highlighting the importance of adopting approaches associated with lesser pain in pediatric populations.

These findings resonate with prior studies, such as those by Murray et al., underscoring the superiority of PNF stretching in improving functional outcomes and reducing spasticity compared to conventional static stretching (27). Similarly, study by Turken Akbayrak et al. support the efficacy of PNF stretching in achieving desired goals of muscle flexibility, range of motion, and pain reduction (14). However, conflicting evidence exists, as evidenced by studies by Elshafey MA et al., indicating the effectiveness of static stretching in reducing spasticity levels (28).

Furthermore, the study assessed the Gross Motor Function Classification score, revealing a slightly better score for the static stretch group, though not statistically significant. This finding counterbalances the advantage observed in the PNF group regarding pre-interventional Ashworth scale scores, suggesting that despite better gross motor function, the static stretch group did not outperform the PNF stretch group. Both groups demonstrated significant improvements post-intervention, indicating the efficacy of both techniques.

Demographic analysis revealed noteworthy gender distribution discrepancies between the groups, with socioeconomic factors potentially influencing pain levels. Despite limitations in sample size and clinician expertise, the study underscores the effectiveness of PNF stretching in reducing spasticity in cerebral palsy patients. Future research endeavors should explore optimal PNF patterns for spasticity reduction and incorporate larger sample sizes for enhanced generalizability.

CONCLUSION

The study rejects the null hypothesis, affirming the superiority of proprioceptive neuromuscular facilitation stretching over static stretching in alleviating spasticity among cerebral palsy patients. Nonetheless, both techniques exhibit efficacy, warranting their consideration in clinical practice. However, further investigations with larger sample sizes and expertise-enriched clinician cohorts are warranted to validate these findings and explore optimal PNF patterns for spasticity management.

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