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Effect of Electrical Stimulation on Spasticity in Spastic Diplegic Cerebral Palsy Children

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Abstract:
Background: Cerebral palsy (CP) is a common developmental disability. CP is defined as an "umbrella term covering a group of non-progressive, but often changing, motor impairment syndromes secondary to lesions or anomalies of the brain arising in the early stages of its development". Neuromuscular electrical stimulation (NMES) involves the application of a series of intermittent stimuli to superficial skeletal muscles, with the main objective to trigger visible muscle contractions due to the activation of the intramuscular nerve branches. The aim is to study the effectiveness of neuromuscular electrical stimulation on spasticity in children with spastic diplegic cerebral palsy children.
Methods: 30 children with an age range of 4-12 years, both males and females with spastic diplegic cerebral palsy were selected from the outpatient department of University College of Physiotherapy, Faridkot. Patients were divided into two groups. Patients in one group were given neuromuscular electrical stimulation of quadriceps for 30 minutes 3 times a week and passive stretching of the hamstrings 3 times per week and the other group received passive stretching of the hamstrings 3 times per week. Total treatment duration was 6 weeks.
Results: All 30 patients completed the treatment. We noted significant improvements for all post interventions scores ($p<0.05$). A significant difference was found in spasticity and range of motion in group one.
Conclusion: This study has shown that neuromuscular electrical stimulation in addition to passive stretching is found to be effective in decreasing spasticity and improving knee range of motion than passive stretching alone.

***Key words**: Cerebral palsy, Electrical stimulation, Spasticity*

1. Introduction

Cerebral palsy (CP) is a common developmental disability first described by William Little in the 1840s. CP is defined as an "umbrella term covering a group of non-progressive, but often changing, motor impairment syndromes secondary to lesions or anomalies of the brain arising in the early stages of its development". [1]CP is traditionally classified according to the type of motor symptoms (spastic, dyskinetic, or ataxic)and the location of impairment (hemiplegia, diplegia, or tetraplegia). The spastic subtype, accounts for 66%–82% of CP cases, which makes it the most common type [2]. Spasticity is defined as 'a motor disorder characterised by a velocity-dependent increase in tonic stretch reflexes (muscle tone) with exaggerated tendon jerks, resulting from hyperexcitability of the stretch reflex' [3].

Stretching programs are an important component of physical therapy intervention with CP children. Neuromuscular electrical stimulation (NMES) involves the application of a series of intermittent stimuli to superficial skeletal muscles, with the main objective to trigger visible muscle contractions due to the activation of the intramuscular nerve branches [4]. To elicit a contraction, two electrodes are placed on the skin overlying the target musculature. Contraction occurs through the stimulation of the intramuscular branches of the nerve supplying the muscle. Two strengthening mechanisms are proposed for the therapeutic effects of NMES: (1) the overload principle, resulting in greater muscle strength by increasing the cross-sectional area of the muscle; (2) selective recruitment of type II fibers (fast-twitch, large diameter fibers), causing improved synaptic efficiency of the muscle [5].

The purpose of this study is to investigate the effect of electrical stimulation on spasticity in spastic diplegic cerebral palsy children.

2. Methods

Ethical approval was granted by the Research & Ethical Committee of University College of Physiotherapy, Faridkot.

2.1. Participants

Thirty children with diplegic cerebral palsy participated in the study. The children were recruited from OPD of University College of Physiotherapy, Faridkot. The children were already diagnosed by a pediatrician of GGS medical college and hospital, Faridkot. The parents or guardians signed consent forms prior to the treatment. 49 CP children were assessed and 30 met the inclusion criteria. To be included in the study, the child has to meet the following inclusion criteria : clinically diagnosed spastic diplegic cerebral palsy children, cerebral palsy children with bilateral knee flexor spasticity, cerebral palsy children with age group : 4-12 years, both males and females, cerebral palsy children with score of 3 or less in ModifiedAshworth Scale. Exclusion criteria included: Recent physiotherapy intervention within three months, subjects with grade 4 spasticity at Modified Ashworth Scale, Ataxic, athetoid cerebral palsy, children on antispatic drugs or other medications, congenital deformities of lower limb, inability of child's parent or care giver participation, previous surgeries for correction of lower limb deformity, associated systemic problems and epilepsy, children using adaptive equipment and assistive devices.

2.2. Procedure

Children were randomly divided into 2 equal groups- GroupA and Group B - by using a computer generated random number table. Randomization was done by a person not otherwise involved in day-to-day functioning of the study. The allocation was concealed using opaque sealed envelopes. Group A received NMES and passive stretching & Group B received passive stretching alone.

Assessment of spasticity (tone) using Modified Ashworth Scale and assessment of the range of motion of knee joint using universal goniometer was done prior to the treatment.

During the application of the neuromuscular electrical stimulation the child was positioned with the knee semi-flexed and the hamstring was not in the lengthened position (Benton 1981) to reduce the amount of stimulation required to attain a forceful contraction and therefore improve patient comfort.Before every treatment neuromuscular electrical stimulator machine was tested and electrodes were cleaned properly. After initial evaluation 15 children were assigned to group Awho received 30 min of neuromuscular electrical stimulation at quadriceps 3 times a week and passive stretching of the hamstrings 3 times per week for 6 weeks. Neuromuscular electrical stimulation was applied using four channel neuromuscular electrical stimulator (Johari Digital Health care Ltd. (V2.1) 11BLD 00061) to the quadriceps. Symmetrical biphasic square waveform with frequency of 30 Hz and pulse width of 0.35ms was used. The duty cycle with 3s on and 3s off with slow burst mode was used. The intensity was set as high as the child was able to tolerate and to produce visible contractions.After the neuromuscular electrical stimulation, three brief stretches were applied to hamstring muscle. An assistant provided fixation while a physiotherapist applied a stretch for 30s (Brandy and Irion 1997) with 1 min rest between three stretches.The control group received passive stretching of the hamstrings 5 times per week, three brief stretches were applied to hamstring muscle, stretch was applied for 30 s with 1 min rest between three stretches.Total treatment duration was six weeks.

3. Data Analysis

The data was analyzed using IBM SPSS -20 statistical analysis software. Paired and Unpaired t-test was applied to compare the effectiveness of neuromuscular electrical stimulation on spasticity in spastic diplegic cerebral palsy. Paired t test and unpaired t test was applied for assessing the variables spasticity and range of motion. Pre test scoring within group A and group B, and post test scoring after 4 weeks and 6 weeks between Group A and Group B variables were performed which showed the order of superiority was Group A>Group B.

4. Results

Comparison between the MAS for right and left side of both groups was done. There was no significant difference in spasticity between group A and group B of right side at 0 day but at the end of 4 weeks and 6 weeks, there was significant difference between both the groups.

There was no significant difference in spasticity between group A and group B of left side at 0 day but at the end of 4 weeks and 6 weeks, there was significant difference between both the groups. Comparison between the knee flexion ROM for right and left side of both groups was done. There was significant difference in knee flexion ROM between group A and group B of both sides at 0 day, at the end of 4 weeks and 6 week.

Comparison between the knee extension ROM for right and left side of both groups has been done. There was no significant difference in knee extension ROM between group A and group B of both sides at 0 day but at the end of 4 weeks and 6 weeks there was significant difference between both the groups.

Within group comparison of MAS, knee flexion ROM, knee extension ROM has been done. In both groups, there's significant difference in readings between 0 and 4^{th}week, between 4^{th} and 6^{th} week and between 0 and 6^{th} week.

5. Discussion

The main objective of the study was to study the effectiveness of NMES on spasticity in spastic diplegic cerebral palsy children. Mohammad A. Khalili and Abdulhamid Hajihassanie (2008) studied the effects of electrical simulation in addition to passive stretch on spasticity and contracture in children with cerebral palsy and concluded that the usefulness of electrical stimulation and passive stretching had a greater effect on spasticity and passive range of motion than passive stretching alone. Daichman et al (2003) studied the effects of NMES home program on impairments and functional skills of a child with spastic diplegic CP. NMES was applied to the quadriceps every other day for 6 weeks and concluded that quadriceps strength increased and hamstring spasticity decreased which improved the strength and motor function in children with diplegic cerebral palsy following NMES.The results of this study are consistent with those of Akinbo et al (2007) who compared the effect of neuromuscular electrical stimulation and cryotherapy on spasticity and hand function in patients with spastic cerebral palsy and concluded that cryotherapy and NMES were found to be effective in the treatment of patients with spastic cerebral palsy. The result of this study is in consistent to present study which showed improvement in spasticity after NMES application. Carmick J. (1993) reported on the clinical use of neuromuscular electrical stimulation for children with cerebral palsy and documented the functional changes that occurred with the application of neuromuscular electrical stimulation to the lower extremity. The results showed preliminary evidence for the usefulness of neuromuscular electrical stimulation as an adjunct to the physical therapy program for improving function in children with cerebral palsy. Hazlewood et al (1994) employed NMES treatment in 10 children with hemiplegic CP on the anterior tibial musculature for 1 hour daily for 35 days, evaluating the effectiveness of the treatment by gait analysis and measuring range of movement and muscle strength and concluded statistically significant improvement in passive and active ankle range of movement and in muscle strength. A review was done by Tamis Pin et al (2006) on the effectiveness of passive stretching in children with spastic cerebral palsy. Seven studies were selected according to the selection criteria and scored against the physiotherapy evidence database scale. Effect size and 95% confidence intervals were calculated for comparison. There was limited evidence that manual stretching can increase range of movements, reduce spasticity, or improve walking efficiency in children with spasticity.

6. Conclusion

This study concluded that both NMES combined with passive stretching is found to be effective in decreasing spasticity and improving knee range of motion in children with spastic cerebral palsy.

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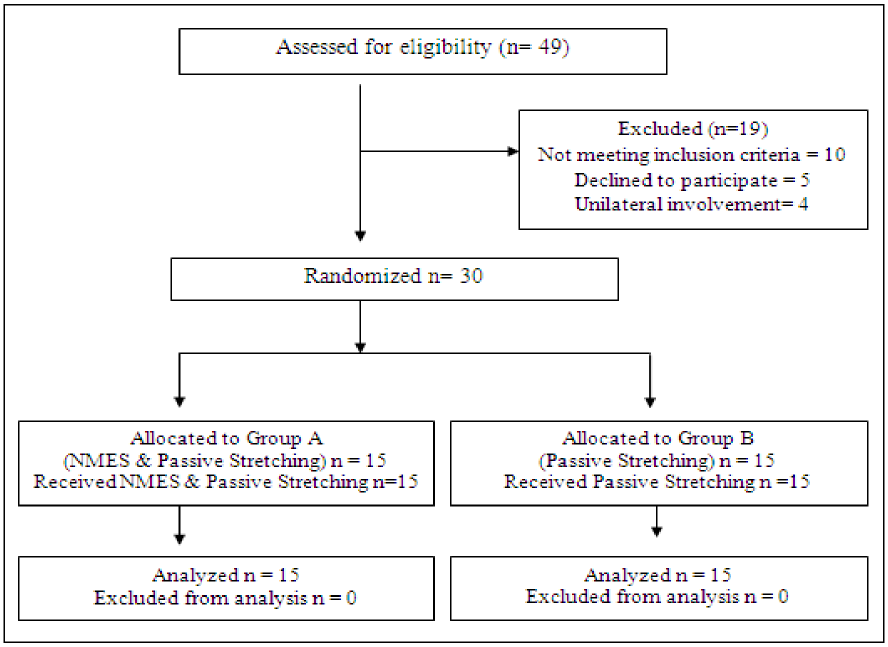

Figure 1: Flow chart of procedure

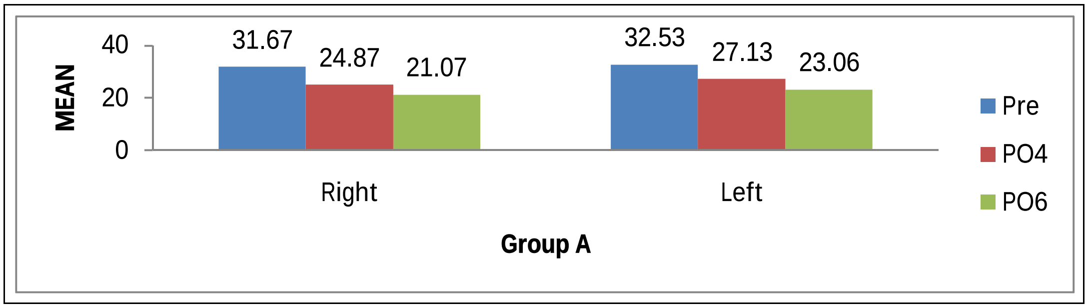

Figure 2: Comparison within Group A of knee extension range of motion

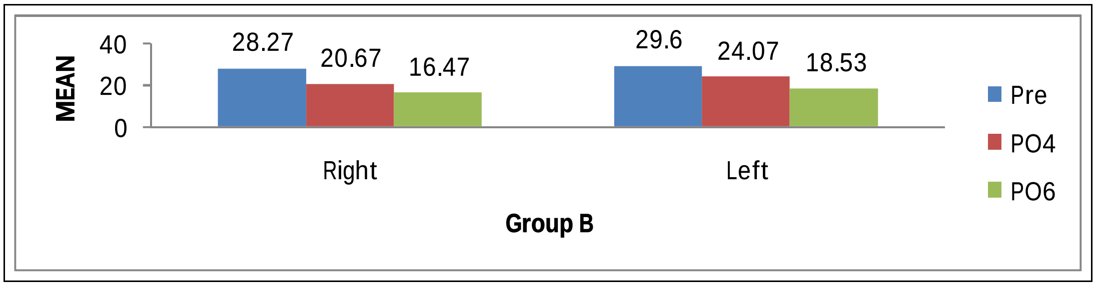

Figure 3: Comparison within Group B of knee extension range of motion

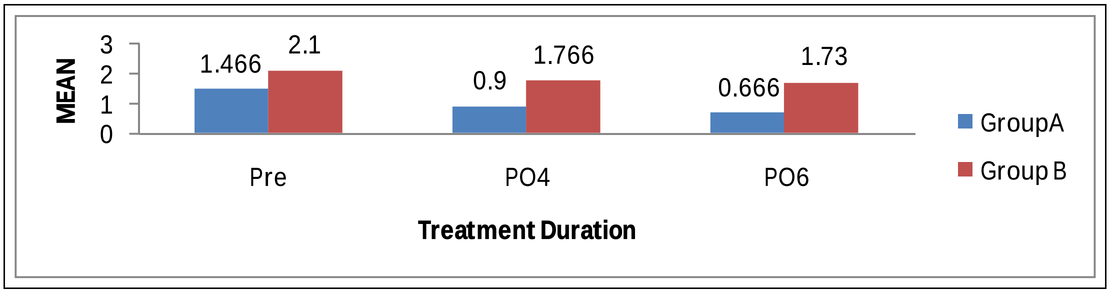

Figure 4: Comparison between Group A & Group B Right Side (MAS)

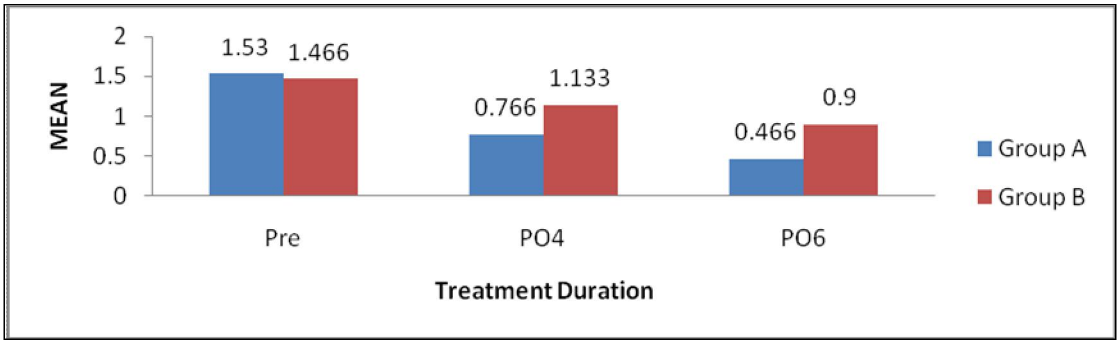

Figure 5: Comparison between Group A & Group B Left Side (MAS)

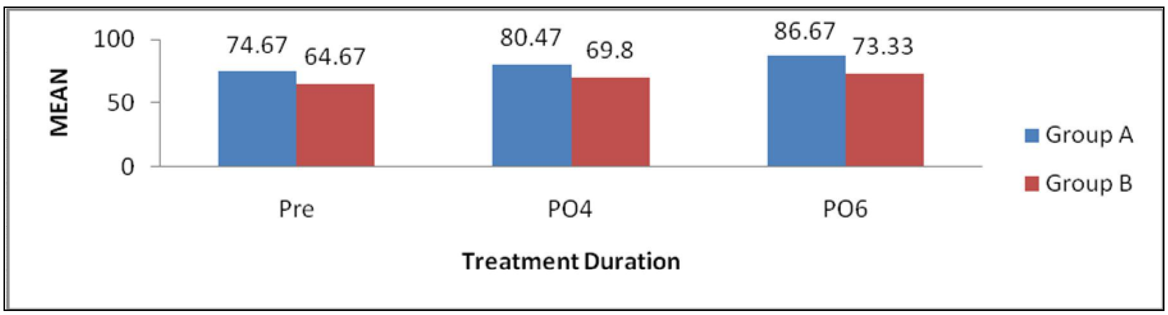

Figure 6: Comparison between Group A& Group B of knee flexion range of motion right side

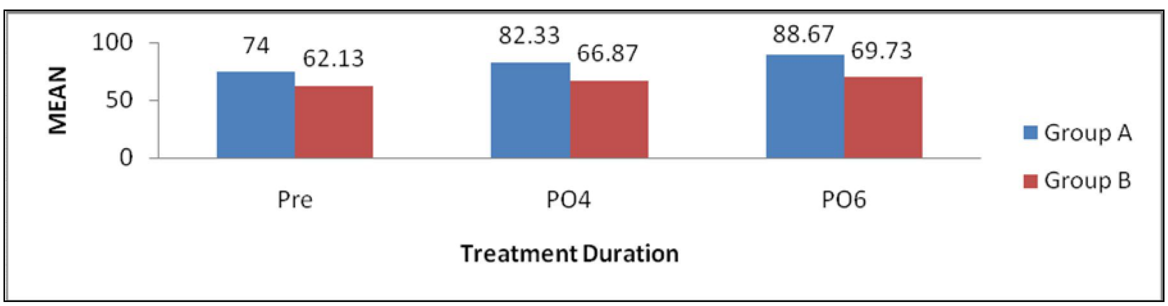

Figure 7: Comparison between Group A& Group B of knee flexion range of motion left side

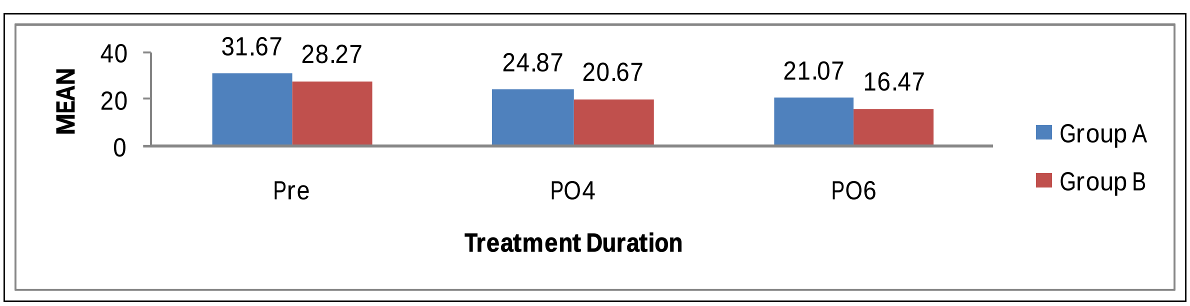

Figure 8: Comparison between Group A& Group B of knee Extension range of motion right side

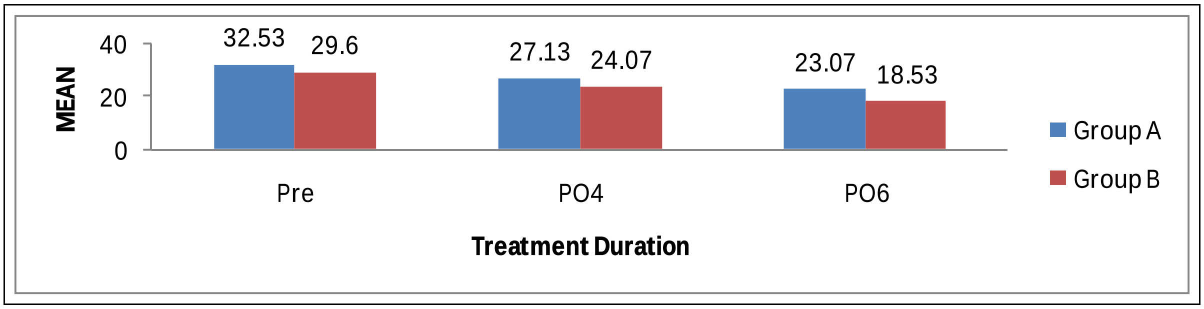

Figure 9: Comparison between Group A& Group B of knee extension range of motion left side