Effect Of Proprioceptive Neuromuscular Facilitation On Selective Motor Control Of Lower Extremity In Children With Hemiplegic Cerebral Palsy: An Experimental Pilot Study

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Abstract: Background: Cerebral palsy children have limitations in motor function resulting in diminished selective motor control. Selective motor control (SMC) is essential for independent control of joint motion. Impaired SMC is interrelated to neuromuscular deficits in CP. In this study PNF approach was used with different patterns and techniques which help to evoke motor responses and improve neuromuscular control and function. Objectives: To assess the effect of PNF along with conventional treatment ,To assess the effect of Conventional treatment and To compare the effect of PNF along with conventional treatment and conventional treatment on selective motor control of lower extremity in children with hemiplegic cerebral palsy. Material and Method: Study included 22 hemiplegic cerebral palsy children which were divided into two groups. Experimental group received PNF and conventional treatment and control group received conventional treatment. SMC of lower extremity was assessed using SCALE. Pre and post treatment scores were measured. Results: There was statistically significant difference noted within group and between groups on Total SCALE score. Difference was seen greater in experimental group than control group. Conclusion: This study suggests that PNF have an effect on selective motor control of lower extremity in children with hemiplegic cerebral palsy. [Kale G Natl J Integr Res Med, 2021; 12(1):46-51]

Key Words: Hemiplegic cerebral palsy, Proprioceptive Neuromuscular facilitation, Selective motor control, Lower extremity, SCALE

Abbreviations: Selective motor control (SMC), Proprioceptive Neuromuscular Facilitation (PNF), Cerebral Palsy (CP), Selective control assessment of lower extremity (SCALE), Diagonal Pattern (D1 and D2), Gross motor function classification system (GMFCS), Corticospinal tract (CST).

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Introduction: CP is caused by an injury to the brain and a poor motor control is hallmark of CP. Children with cerebral palsy have difficulty in movement because of impaired coordination in muscle recruitment. Because of which they have problems in isolated muscle actions. Selective motor control has been defined as 'the ability to isolate the activation of muscles in a selected pattern in response to demands of a voluntary movement or posture'[1].

Alteration in SMC forms an impairment results from the inability to activate muscles affecting a person's ability to perform functional tasks. SMC is related to integrity of the corticospinal tract (CST), which is damaged in children with CP[2].

Children with cerebral palsy have decreased strength in lower limb muscles, impaired coordination and gait and poor motor control. Studies stated that PNF techniques are effective in improving muscle strength, posture, trunk control and gait and coordination.

Reduced SMC caused by flexor or extensor synergies interfering with isolated joint movements impair functional movements such as gait[3]. SMC is needed to position the limb for weight bearing at the beginning of each step.

Loss of descending control leads to abnormal input to motor neuron pools in the spinal cord, which may result in failure to develop or maintain the complex spinal networks involved in muscle activation patterns of agonists, synergists, and antagonists[4,5,6,7]. The SCALE is the most current assessment of SMC. It grades an individual's ability to perform isolated, voluntary joint movements. PNF helps in increasing reactions of neuromuscular mechanism through stimuli. It is effective to develop muscular strength, facilitate stability, mobility, neuromuscular control and coordinated movements help for restoration of function, regaining motor control and enhance the muscle strength in paretic limbs of cerebral palsy subjects[8,9,10].

Impaired SMC usually occurs with muscle weakness, spasticity and short muscle tendon length. Abnormal muscle tone causes a selective loss of muscle control and lack of balance between agonists and antagonists.

Loss of motor control interferes much more with motor performance resulting in limitation of movement quality.

There are few studies done on the effectiveness of PNF in children with cerebral palsy. Children with cerebral palsy have altered motor patterns and an impaired selective control which makes their movements abrupt and uncoordinated.

PNF is a hands on approach which has evidence in improving muscle coordination and motor activities. Even if there are few studies on effect of PNF those studies are mostly done on upper extremity control. So the present study focuses on lower extremity SMC improvement using PNF approach.

Material and Methods: After obtaining Institutional Ethical Clearance the hemiplegic cerebral palsy children were recruited for the study as per the inclusion and exclusion criteria.

The nature of study was explained to parents and signed written assent was obtained. Patient diagnosed with hemiplegic cerebral palsy between 4-12 years of age, both the genders, GMFCS Level I, II and III able to communicate and follow instructions. Flexor or Extensor synergy was included.

Subjects who had undergone prior orthopedic/ surgical procedure of involved lower extremity, who had received botulinum toxin injection in past 6 months for Lower Extremity Muscles, who were taking oral or intrathecal myorelaxant drugs, Fixed deformities, Mixed synergies, Sensory involvement were excluded from the study. Subjects who were willing to discontinue the treatment were withdrawn from the study.

Selective Control Assessment Of Lower Extremity (SCALE): It was used to assess selective motor control of entire lower extremity in spastic CP children by summing scores of 5 joints (Hip, knee, ankle, subtalar joint and Toes)and it was scored to differentiate between muscle weakness and lack of selective control and ability to move each joint selectively.

Study design was an experimental pilot study and convenient sampling was done. Randomization was done by a computer generated random number chart.

Sample size was 22 i.e. 11 in each experimental group (Group A) and control group (Group B). Subjects were clinically diagnosed cases of Hemiplegic CP between age group 4-12 years, who fulfilled the inclusion criteria.

Group A: PNF and Conventional treatment given. Depending upon the affection or type of synergy present PNF pattern and technique was decided[8,9,11,12]. For Flexor synergy -D1&D2 Extension, for Extensor synergy- D1&D2 Flexion. Techniques: Combination of isotonics and Dynamic reversal.

Group B: received 1 hour conventional treatment of active ROM, active assisted ROM exercises for hip, knee, ankle, passive stretching of Hamstrings, adductors, calf muscle , pelvic bridging, mini squats, stepping (forward, backward, sideways), stair climbing. The group A received same conventional PT treatment.

Both groups received upper extremity conventional PT treatment like Fine motor activities, stretching and strengthening. Both groups received treatment for 1 hour, 5 times in a week for 3 weeks.

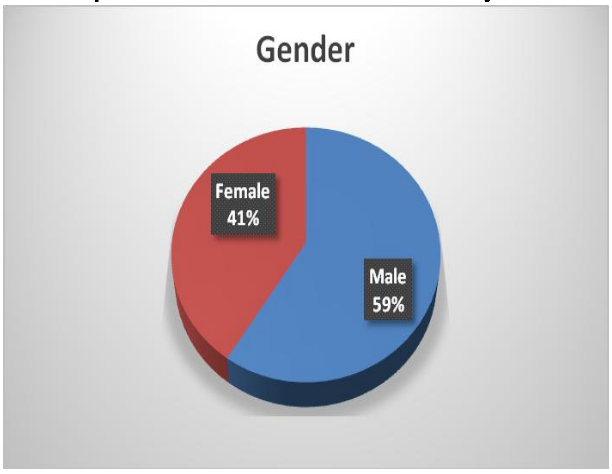
Selective motor control for Lower extremity was assessed at the end of 3 weeks and the difference between pre and post treatment scores was measured.

Result: The data was processed in SPSS 17.0 software. Descriptive statistics calculated for demographic variables. Baseline data was assessed.

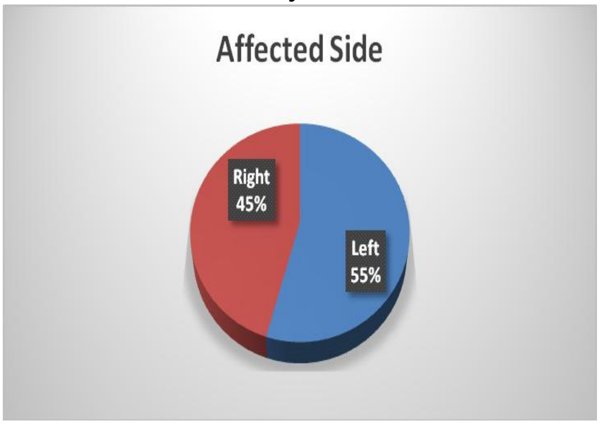
For Intragroup analysis Wilcoxon Signed-Rank test was used. For Intergroup analysis Mann-Whitney U test was used. Overall out of 22 samples, 20 completed the study.

10 in Experimental group and 10 in the Control group. 1 dropped out from each group due to personal reasons.

Graph 1: Gender Distribution In Subjects



Graph 2: Distribution Of Affected Side In Subjects



Graph 3: Distribution Of GMFCS Level In Subjects

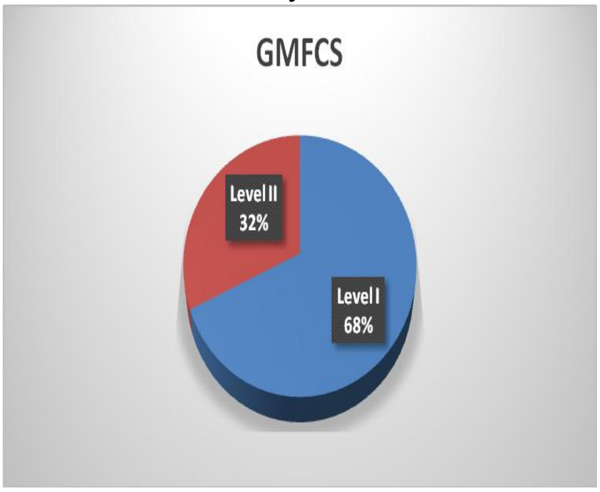


Table 1: Intragroup Analysis Of Mean Difference On SCALE

Joint	Group	Score	Mean ± SD	P value	Result
Hip	Experimental	Pre	1.80±0.42	0.157	NS
		Post	2.00±0.00		
	Control	Pre	1.60± 0.52	0.317	NS
		Post	1.70± 0.48		
Knee	Experimental	Pre	1.60± 0.52	0.157	NS
		Post	1.80± 0.42		
	Control	Pre	1.42± 0.52	0.157	NS
		Post	1.60± 0.52		
Ankle	Experimental	Pre	1.00± 0.00	0.008	Sig
		Post	1.70± 0.48		
	Control	Pre	1.00± 0.00	0.083	NS
		Post	1.30± 0.48		
Subtalar	Experimental	Pre	1.00± 0.00	0.046	Sig
		Post	1.40± 0.52		
	Control	Pre	1.00± 0.00	1.000	NS
		Post	1.00± 0.00		
Toes	Experimental	Pre	1.00± 0.00	1.000	NS
		Post	1.00± 0.00		
	Control	Pre	1.00± 0.00	1.000	NS
		Post	1.00± 0.00		

Table 2: Intergroup Analysis Of Mean Difference On Scale

Joint	Group	P value	Result
Hip	Experimental	0.542	NS
	Control		
Knee	Experimental	1.000	NS
	Control		
Ankle	Experimental	0.081	NS
	Control		
Subtalar	Experimental	0.029	Sig
	Control		
Toes	Experimental	1.000	NS
	Control		

Table 3: Intragroup Analysis Of Mean Difference Of Total Score On Scale

Total Score		Mean	SD	P-Value	Result
Experimental group	Pre	6.40	0.84	0.004	Sig
	Post	7.90	1.20		
Control group	Pre	6.00	0.94	0.014	Sig
	Post	6.60	1.26		

Table 4: Intergroup Analysis Of Mean Difference Of Total Score On Scale

Total Score	Group	P value	Result
	Experimental	0.003	Sig
	Control		

The results showed in intragroup comparison of experimental group, Hip, Knee, and Toes, yielded a p value p>0.05 which was statistically not significant. But Hip and knee values showed clinically significant difference as shown by an increase in post treatment scores. In control group Hip, Knee, Ankle, Subtalar joint and Toes failed to show statistically significant results post treatment. A few subjects showed clinically significant changes in Hip and knee components i.e. as compared to Pre treatment scores, their Post treatment scores were improved.

In Intergroup comparison, it was found that Hip, Knee, Ankle, and Toes showed P> 0.05, which was statistically not significant. But in post treatment their clinically significant changes were noted in hip, knee, ankle and subtalar joint in experimental group. Clinically, on Total SCALE score, the difference seen in experimental group was more as compared to the control group.

Discussion: Lack of selective voluntary control leads to alteration in joint kinetics and kinematics[13]. In hemiplegic CP distal impairment and muscle weakness was more compare to proximal, causing imbalance of muscle activity across joints. Weak dorsiflexors, results in disturbances in distal joints. Toe-walking children have reduced power generation of their gastro-soleus complex[14].

In experimental group, found that Combination of isotonic techniques for proximal musculature of hip helps to develop eccentric control[8,11]. Post treatment, Dorsiflexion, Inversion and Eversion movements showed improvement. The muscles controlling the foot and ankle complex can act either concentrically, i.e. by shortening or eccentrically i.e lenghtening.

In hemiplegic CP in ankle foot complex any disturbance in the properties of plantarflexors, dorsiflexors, invertors and evertors, [14]leads to tightness; weakness or spasticity which disrupt the smooth function of the foot.

In control group it was found that with conventional treatment like stretching and strengthening exercises, good muscle function is promoted which helps to increase muscle length and muscle balance thereby improving joint integrity. Isolated movements then begin to develop in the agonist muscle while the antagonist muscle relaxes. Distally the impairment was more as compared to proximal and it was observed that proximal recovery occurs prior to distal recovery. Eileen G Fowler found that the somatotopic organization of the lower extremity in the sensorimotor cortex suggests that distal lower-extremity tracts are closer to the ventricle and more vulnerable than those of proximal lower-extremity muscles[2].

Distal muscles were generally weaker than proximal muscles. Although the insertions of the toe musculature are more distal, the origin of muscles controlling the ankle, subtalar joint, and toes are similar. There may be greater capacity for sparing of corticospinal fibers associated with toe movement owing to greater density of CSTs[15,16]. The studies thus provide merit to the findings of the present study wherein we observe that distal impairment was seen more in ankle joint, subtalar joint and toes although with the exception that we found toes to be more severely affected than the subtalar joint.

In Intergroup comparison we found that as PNF uses diagonal and spiral pattern of movements applied along with their different techniques, which allows to target specific muscle groups and help to improve inter joint coordination.

Using PNF, enhances balancing ability by stimulating proprioceptive sense of muscles and tendons and also helps to strengthen muscle and improve selective motor control and flexibility in lower extremity.

PNF studies are maximally done on adult population and very few studies have tested the effects of PNF on the pediatric population. Those testing effects of PNF on the pediatric population primarily focused on studying the effects of PNF on balance, gait and function.

There is dearth of literature testing effects of PNF on selective motor control in Adult as well as pediatric population. Lower extremity studies in hemiplegic cerebral palsy have thus received less attention.
It was noted that fast recovery was achieved in children with GMFCS Level I compared to GMFCS level II. Age group of 4-6 yrs showed better improvement as compared to ages 7-12yrs. Karen Pape et. al stated that by this age, children with cerebral palsy develop the typical patterns of spasticity. The brain is actively growing, repairing and recognizing to restore the function.

Beyond this age group, children over number of years, develop a pattern and habituate to the same in accordance with their musculoskeletal and neuro-motor affection. By this age, the first burst of neuroplasticity is over and the brain has repaired to whatever extent that it can. Age has a direct relation with growth spurt. In children as age increases bones grow faster than muscle and muscle become tighter.

If muscle is to keep up with bony growth it requires both passive stretch and active contraction, which should occur during normal activity, e.g. walking. The loss of normal muscle stretch leads to muscle shortening, which in turn leads to the loss of the normal balance of agonists and antagonists. This is particularly important where there is spasticity of larger muscle groups, e.g. the gastrocnemius and soleus[17,18].

The current study found that PNF in Hemiplegic cerebral palsy children can help to improve their selective motor control and voluntary activation of weaker muscles in lower extremity and is recommended to be used as an adjunct to conventional therapy, as an early intervention.

Conclusion: PNF can be use as an adjunct to conventional treatment in children with hemiplegic cerebral palsy as it showed positive effects. Before any fixed deformity sets in, PNF can be used as a treatment approach effectively in younger children before 6 years of age. Long term follow up for carryover effects of PNF were not assessed. This study concluded that there was a positive effect of PNF on selective motor control of lower extremity in children with hemiplegic cerebral palsy.

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