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THE EFFECT OF PROPRIOCEPTIVE NEUROMUSCULAR FACILITATION (PNF) TECHNIQUE ON TRUNK CONTROL AND FUNCTIONAL BALANCE IN SUBJECTS WITH CEREBRAL PALSY. A RANDOMIZED CONTROL TRIAL.

Physiotherapy

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ABSTRACT

Background: Cerebral palsy (CP) is a disorder of the development of movement and posture due to non-progressive impairment in the developing brain. It is commonly associated by impaired speech, mental retardation, visual impairments, perceptual disorders and epilepsy. Common characteristics in all types of Cerebral palsies are motor delay, postural imbalance, defect in infantile reflexes, intellectual impairment, and disturbed sensory perception. Trunk control is one of the most common impairments which affects the functional balance in children with cerebral palsy. The trunk plays a key role in maintaining the postural control mechanism ad also in the organization of balance reactions during the developmental stage. Functional balance is a component of postural control that aids the child in carrying out everyday tasks and engaging in social and recreational activities on their own at home, at school, and in the community. **Aim:** To determine the effect of Proprioceptive Neuromuscular Facilitation (PNF) techniques on trunk control and functional balance in children with cerebral palsy. **Method:** Thirty children were included in the study selected on the basis of inclusion, exclusion criteria and the children were assigned into two groups i.e. Group A (experimental group) and Group B (control group) after obtaining informed consent from their parents. Group A children received PNF and Swiss ball training and Group B children received only Swiss ball training for 30 minutes, 4 times weekly for 6 weeks duration. Trunk Control Measurement Scale (TCMS) was used to assess trunk control and Pediatric Balance Scale used to assess the functional balance. **Results:** There is a significant improvement in both the groups but on comparison between experimental group and control group, the experimental group showed higher significant improvement than control group ($p < 0.001$). **Conclusion:** This study concluded that combination of PNF techniques and Swiss ball training have shown high a significance improvement than Swiss ball alone on trunk control and functional balance in children with cerebral palsy.

KEYWORDS

Cerebral palsy, Swiss ball, Proprioceptive Neuromuscular Facilitation, Trunk control measurement scale, pediatric balance scale.

INTRODUCTION

Cerebral palsy (CP) is a disorder of the development of movement and posture due to non-progressive impairment in the developing brain. It is commonly associated by impaired speech, mental retardation, visual impairments, perceptual disorders and epilepsy (1,2). Current prevalence of CP in high-income countries is 1.6 per 1000 live births (3). The prevalence of CP in India is around 2.95 per 1000 babies (4). CP is caused by factors affecting brain development or damage before, during, or after birth. Prenatal causes include infections, genetic abnormalities, and maternal health conditions Perinatal causes involve birth asphyxia, premature birth, and low birth weight (5). Postnatal causes include traumatic brain injuries, infections such as meningitis, and severe neonatal jaundice (6). The topographic classification of CP is hemiplegia, diplegia, and quadriplegia. Another classification is based on motor function as pyramidal: spastic and extrapyramidal: non-spastic including athetoid, ataxic, and dystonic (7). Common characteristics in all types of Cerebral palsies are motor delay, postural imbalance, defect in infantile reflexes, intellectual impairment, and disturbed sensory perception. It primarily affects motor function due to abnormal brain development (8). The majority of children with CP have difficulty in walking and have poor coordination and balance, which impairs their gait and their ability to reach because stability is essential to all movements (9). One of the key characteristics of children with cerebral palsy is a deficient of postural control mechanisms (10).

The postural control mechanism maintains the head and trunk in a vertical posture during the process of development, providing a stable foundation for carrying out necessary actions such as sitting, reaching, standing, and walking (11). The trunk plays a key role in maintaining the postural control mechanism and also in the organization of balance reactions in this developmental stage (10). Trunk control is impaired in children with CP thus influencing their functional balance (12) Functional balance, is a component of postural control, aids a child in carrying out everyday tasks and engaging in social and recreational activities on their own at home, at school, and in the community (13,14). The inadequate postural control mechanism in children with cerebral palsy impairs their functional balance. The impaired trunk control and balance increases the risk of falls which further affected children with CP in performance of Activities of Daily Living (ADL), mobility and participation (14). Treatment available for trunk control and balance are core strengthening exercises, Swiss ball training exercises, hippotherapy, NDT. Proprioceptive neuromuscular facilitation integration pattern stimulates the proprioceptors with in the muscle and tendon to enhance the performance, flexibility and balance. It is generally effective in maintaining the reaction of exercise unit by increasing the co-ordination which react to the stimulation in muscular strength and flexibility. It also provides the stability of trunk.

However, there are many individual studies available where trunk PNF techniques and Swiss ball training exercises have shown improvement on trunk control and balance in Cerebral palsy but less literature is available on the combination of PNF techniques and Swiss ball training, and also these have not emphasized on static, dynamic, functional balance in specific among cerebral palsy. Therefore, the current study aims to determine the effect of PNF on trunk control and functional balance in subjects with cerebral palsy.

Objectives Of The Study

- To evaluate the effect of PNF techniques and Swiss ball training on trunk control by using Trunk Control Measurement Scale (TCMS) and Pediatric Balance Scale (PBS) in experimental group children with cerebral palsy.
- To evaluate the effect of Swiss ball training on functional balance by using Trunk Control Measurement Scale (TCMS) and Pediatric balance scale in control group children with cerebral palsy.
- To compare the effect of PNF techniques and Swiss ball training in experimental and Swiss ball training only in control groups on trunk control and functional balance by using Trunk control measurement scale and Pediatric balance scale for children with cerebral palsy.

MATERIALS AND METHODS:

This randomized control trial was conducted at SVIMS (Neurology, College of Physiotherapy, Pediatrics), DEIC RUIA, Ayurvedic Hospital with a sample size of 30 participants, selected through purposive sampling. The study lasted for four weeks, with sessions conducted four days per week, total 16 sessions, each lasting 50 minutes. Ethical approval for the study was obtained from the Institutional Ethics Committee, SVIMS, Tirupati. (Roc.No.AS/11/IEC/SVIMS/2017) ICE no.1747.

Materials:

Swiss Ball: size of ball is 45cm for less than 155cm height ,55 cm for

156-165cm height ,65cm for 165 -178 cm height ,75cm for over 178 cm height, Mat, Table, Chair.

Inclusion Criteria
- Children with of 5 to 14 yrs
- Children include both males and females
- All types of children with CP subjects
- Children with GMFM (Gross motor function measure scale scale) with sitting balance between 10 – 30.
- Children with MMSE >24

Exclusion Criteria
- Children with Mental retardation
- Children with recurrent epilepsy
- Children with Spinal deformities
- Children with Sensory impairment
- Children with Botox injection within 6 months

Study Procedure:
All the Children fulfilling the inclusion criteria are recruited in the study. Informed consent was obtained from the parents before study. Prior to treatment session, trunk control and balance were assessed using trunk control measurement scale and PBS and the values were recorded as pre-test values.

The complete treatment procedure was done under the supervision of their parents by the physiotherapist with standard guidelines. The entire treatment protocol was given passively by the physiotherapist and home exercises are taught to the parents. The participants will be allocated in to 2 groups. GROUP A - PNF and Swiss ball training, GROUP B- Swiss ball training. After the intervention of 4 weeks, the Children were assessed again to evaluate the trunk control and balance using GMFM scale and PBS and the values were recorded as post-test values**.**

Outcome Measures:
The Trunk Control Measurement Scale (TCMS) assesses trunk control in children with cerebral palsy (CP) through 15 items: five for static sitting balance (SSB) and ten for dynamic sitting balance (DSM). Items are scored on a Likert scale (0–1, 0–2, or 0–3), with a total possible score of 58 (SSB: 20, Selective Movement: 28, Dynamic Reaching: 10). Higher scores indicate better performance.

The Pediatric Balance Scale (PBS), a modified Berg Balance Scale (BBS), evaluates functional balance in children through 14 criterion-referenced items. Each item is scored on a 4-point scale.

Interventions
PNF Technique
- Upper trunk flexion with rotation to the left (chopping).
- Upper trunk extension with rotation to the right (lifting).
- Lower trunk flexion with rotation to the left.
- Lower trunk extension with rotation to the right.
- Left lateral flexion with flexion bias.
- Right lateral flexion with extension bias.

Figure -1 Chopping to the left in supine
Figure-2 Lifting to the left in supine

Swiss Ball Training:
- Sit on the ball and rolled the ball side to side.
- Sit on the ball with the lower extremities in a dissociated position and moved the ball forward and backward diagonally.
- Sit on the ball and gave extension rotation and flexion rotation to the child.
- Sit on the ball and work on rotation of the trunk with a stable pelvis and hips. An activity of reaching in different directions allowed the child to work on the trunk and lateral weight shifting.
- Supine on the ball with feet on the floor. Held through the lower abdomen to stabilize them on the ball. Then facilitated through one arm and brought the child diagonally up to stance

Figure -3 Lower trunk flexion in supine
Figure -4 Lower trunk extension in supine

Figure -5 Left lateral flexion with flexion bias
Figure-6 Right lateral flexion with extension bias

RESULT:
Demographic Variables: Age
Table- 1 It shows participants in both groups are arranged according to their age groups, it concludes that the majority of the subjects in experimental group are eight years old, whereas the majority of the subjects in control group are six years old.

Age	Experim-ental group	Control group	χ2-value	P value
	Count	Count		
5years	2	2	3.867	0.869
6 years	2	3		
7 years	1	1		
8 years	4	2		
9 years	1	2		
10 years	2	1		
11 years	0	2		
12 years	1	1		
13 years	2	1		
14 years	0	0		
15 years	0	0		
Total	15	15		
Mean	8.5333	8.4000		

Type of CP:
Table-2 It shows in experimental group Spastic Quadriplegia and Spastic Diplegia are more in number than other types of CP. In control group, Spastic Quadriplegia is more in number than other types of CP.

Type of cerebral palsy	Experime-ntal group	Control group	χ2-value	P value
	Count	Count	3.111	0.795
Spastic quadriplegia	4	5		
Spastic diplegia	4	4		
Spastic RT hemiplegia	2	2		
Spastic left hemiplegia	1	1		
Ataxic cp	2	2		
Mixed cp	2	0		
Athetoid cp	0	1		
Total	15	15		
Mean	3.6000	4.0000		

Table-3 Comparison within Experimental group between pre- and post-values

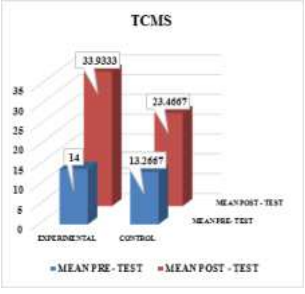
Control group	Test	Mean	SD	Mean Differences	t-value	p-value
TCMS	Pre-test	26.86	2.47	9.80	27.64	<0.001
	Post-test	36.66	2.87			
PBS	Pre-test	13.26	3.03	10.2	22.18	<0.001
	Post-test	23.46	3.02			
Result was found highly significant in post-test values of TCMS and PBS in the control group with a statistical significance of $p < 0.001$.						

Table-4 Comparison within Control group between pre- and post-values

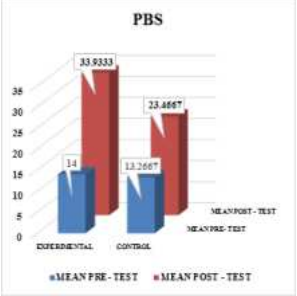
Experim-ental Group	Test	Mean	SD	Mean Differ-ences	t-value	p-value
TCMS	Pre-test	27.0	2.87	16.06	24.97	<0.001
	Post-test	43.06	3.89			
PBS	Pre-test	14	3.72	19.93	29.34	<0.001
	Post-test	33.93	5.72			
Result was found highly significant in post-test values of TCMS and PBS in the Experimental group with a statistical significance of $p < 0.001$.						

Table -5 Comparison of experimental and control groups pre- and post-values of TCMS and PBS

	Group	Mean	SD	T-value	P value
TCMS PRE-TEST	Group A	27	2.87	0.136	0.893
	Group B	26.86	2.47		
TCMS POST-TEST	Group A	43.06	3.89	5.1	<0.001
	Group B	36.66	2.87		
PBS PRE-TEST	Group A	14	3.72	0.591	0.559
	Group B	13.26	3.03		
PBS POST-TEST	Group A	33.93	5.72	6.262	<0.001
	Group B	23.46	3.02		
Results indicate that the experimental group had a higher mean difference compared to the control group, significantly improved in the post-test values of the experimental and control group where p<0.001.					



Graph 1: Graphical presentation of comparison of TCMS between groups



Graph 2: Graphical presentation of comparison of PBS between groups

DISCUSSION:

This study aimed to evaluate the combined effects of Proprioceptive Neuromuscular Facilitation (PNF) and Swiss ball exercises on trunk control and functional balance in individuals with cerebral palsy (CP). Both the experimental group (PNF + Swiss ball exercises) and the control group (Swiss ball exercises only) showed significant improvements, but the experimental group demonstrated greater mean difference in Trunk Control Measurement Scale (TCMS) and Pediatric Balance Scale (PBS) scores. The experimental group showed a mean TCMS increase from 27.00 to 43.07 and a mean PBS increase from 14.00 to 33.93, while the control group improved from 26.87 to 36.67 (TCMS) and 13.27 to 23.47 (PBS). The statistical significance ($p < 0.001$) supports the enhanced benefits of combining PNF with Swiss ball exercises. The synergistic effect of PNF and Swiss ball exercises provides greater improvements in trunk control and functional balance compared to Swiss ball exercises alone. PNF stimulates proprioceptors, enhancing neuromuscular efficiency, motor control, and muscle activation. It also improves sensory input and cortical activation, which strengthens muscle coordination and motor responses. Additionally, PNF techniques, such as rhythmic initiation and diagonal movement patterns, facilitate trunk control and postural alignment, contributing to overall movement efficiency. Swiss ball exercises challenge postural control by requiring core muscle engagement to maintain stability on an unstable surface. They enhance equilibrium reactions, promoting dynamic stability and trunk muscle endurance. Furthermore, Swiss ball exercises improve adaptive balance responses, which play a crucial role in maintaining overall postural stability. Previous studies (Selvaraj & Ranjitha, 2021) confirm that PNF is effective in improving trunk control in CP. Additionally, research by (Shinde & Ranvir 2019) suggests that PNF and Swiss ball exercises have equal effectiveness in trunk control, but their combination maximizes neuromuscular activation. A meta-analysis (Shinde & Ranvir, 2014) further supports that PNF increases sensory input and pyramidal tract excitability, leading to improved motor neuron activation. The findings confirm that PNF combined with Swiss ball exercises provides superior benefits for trunk control and balance compared to Swiss ball exercises alone. The study rejects the null hypothesis and supports the use of PNF and Swiss ball exercises as an integrated approach to enhance trunk stability, postural control, and functional balance in individuals with CP.

CONCLUSION

This study concluded that combination of PNF and Swiss ball training have shown high significant improvement than Swiss ball alone on trunk control and functional balance in children with Cerebral palsy.

Limitations

- Sample size is small in the study.
- The duration of the study is small.
- No further follow up was conducted.
- Study included children with all types of CP rather than focusing on specific subtypes.
- No quantitative measures were used in assessing the trunk control and balance.

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