Effect of Vibratory Inhibition and Pelvic Stabilization Exercise on Tone, Balance and Gross Motor Function in Spastic Cerebral Palsy- A Comparative Study

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ABSTRACT

Objectives: Cerebral palsy is one of the leading causes of movement and posture disorders. Recently, Vibration therapy as a treatment method in clinical practice has been used as a complementary approach. This study compared the effects of Segmental Muscle Vibration and Pelvic Stabilization Exercises on Muscle Tone, Balance, and Gross Motor Function in spastic CP children.

Materials and Methods: A total of 20 children with Spastic Cerebral Palsy, of both sexes (age range of 4-6 years) were included in the study. The children were assigned into two groups. Group A received Segmental Muscle Vibration along with conventional treatment i.e. Passive Stretching Exercise and Group B received Pelvic Stabilization Exercise along with conventional treatment for 40 minutes, 3 times a week for 3 weeks. Outcome measures include Modified Ashworth Scale, Pediatric Balance Scale and Gross Motor Function Measure-88 for measuring Tone (spasticity), Balance and Gross Motor Function.

Results: A significant improvement in all variables (p < 0.05) was observed in each group, with greater improvement in tone, balance and gross function indices in group A.
Conclusion: From the results we concluded that both the Segmental Vibration Inhibition Therapy and Pelvic Stabilization exercise yielded a clinically significant improvement in spastic CP; but Segmental Vibration Inhibition Therapy shows more improvement in reduction in tone, improvement in balance and gross motor function.

Keywords: Cerebral palsy; balance; posture; gross motor function; segmental muscle vibration and pelvic stabilization exercise.

1. INTRODUCTION

Cerebral Palsy (CP) is a group of permanent disorders of the movement and posture, which causes activity limitation that is attributed to non-progressive disturbances that occurred in the developing fetus or infant brain (Sophie, L. 2019). It is the most common childhood disability; approximately 2-2.5 cases per birth are the worldwide prevalence of cerebral palsy. It is estimated that in India at around 3 cases per 1000 live births are affected by CP [1]. In Cerebral Palsy central nervous system damage is occurred which causes various disorders in neuromuscular, musculoskeletal and sensorial systems [2]. The pathophysiology of Cerebral Palsy depends on birth; it can happen before birth or shortly after birth by various causes and risk factors. The causes of CP vary from child to child which includes very low birth weight, multiple births and intrauterine infection. One of the major causes of CP is brain damage which is caused by anoxia, abnormal development of the brain, perinatal stroke, intracranial bleeding, excessive neonatal asphyxia, hypoglycemia, or neurotrophic virus [3]. CP has many clinical risk factors during pregnancy like genetic mutations and probable environmental triggers such as bacterial and viral intrauterine infection, antepartum hemorrhage, intrauterine growth restriction (IUGR), tight nuchal cord and threatened miscarriage [4].

Cerebral palsy is classified according to the parts of the body involved and by the clinical description of tone and involuntary movements. (a) According to an area of the body (distribution) showing impairment CP is - Monoplegia, Diplegia, Hemiplegia, and Quadriplegia; (b) Classification according to perceived clinical signs includes Spastic, Dyskinetic, Hypotonic, Ataxic, Mixed Type [5]. Among perceived clinical signs Spastic CP is the most common type among all types. According to a research 93.75% of the patients have Spastic Cerebral Palsy [6]. Spasticity is a result of the upper motor lesion and can cause secondary disorders such as scoliosis, knee contractures hip, dislocation, torsional-alignments of the femur and tibia, etc. [7]. Spastic Cerebral Palsy is associated with delayed development of mechanisms of postural stabilization and postural adjustments of the head and trunk as well as the pelvic and shoulder girdles. The deviation of pelvic alignment in the standing positions is a common problem in children with cerebral palsy. Such children retain an anterior pelvic tilt due to the contracture of the iliopsoas muscles as well as weakness in the trunk flexors and hip extensors. Impaired postural control limits a child’s re-active balance control, which is the ability to recover from unexpected threats to stability [8].

Spastic Cerebral Palsy can be managed by Surgical and Conservative treatment approaches. Surgical Management shows various orthopedic and neurosurgeries. On the other hand, Conservative management includes Medical management and Physiotherapy management. In Medical Management, different symptoms of Spastic CP can be treated by Antispastic Drugs [9]. These medications have risks and the potential side effects also. They are not currently considered a permanent solution for muscle spasticity in children with cerebral palsy [10]. Another effective method of Conservative Management is Physiotherapy. The goals of physiotherapy is to improve or established independent mobility, to promote functional movement, to improve performance of Activity of daily living in CP patients [11]. Physiotherapy treatment includes Pelvic Core stabilization programs for children with Cerebral palsy to improve their fine and gross motor functional movements which include various exercises. This program also improve gait, postural control, balance, stability and reduced muscle tone [12]. Recently, use of vibration therapy is increased for achieving therapeutic or physical performance goals [13, 14, & 15]. In which Segmental Muscle Vibration (SMV) is one of the type which is used to improve motor function and inhibit spasticity [16]. In this technique by using a mechanical device a vibratory stimulus is given to a specific muscle which induces the generation of la fiber inputs as an outcome of the activation of muscle...
spindle primary endings [17]. Therefore, the purpose of this study was to compare the effects of SMV and pelvic stability program on tone, balance and gross motor function in children with spastic CP, with an intervention period of 3 weeks.

2. MATERIALS AND METHODS

An experimental study was conducted at the SGT Medical College Hospital & Research Institute, Gurugram Haryana and Kota, Rajasthan, India.

2.1 Sample Size Calculation

A sample size of 34 was calculated using the G-power software.

2.2 Inclusion Criteria

Subjects with Spastic cerebral palsy, Age group 4-6 years [18], Able to ambulate i.e Independent or assisted and Based on Gross Motor Function Classification System (GMFCS) criteria level I-III. [19] were included in the study

2.3 Exclusion Criteria

Participants were excluded if they had been on antispastic drugs in the last six months, had undergone any orthopedic or neurosurgery within the previous 12 months, moderate to severe intellectual disabilities, experienced a seizures episode within the past 12 months, Cognitive impairment, inability to comply with the required procedure and any musculoskeletal problem like muscle disease, congenital limb deficiency etc. [20].

2.4 Outcome Measures

Baseline and post outcome measurements included the Modified Ashworth Scale, Pediatric Balance Scale and Gross Motor Function Measure-88 for measuring Tone (spasticity), Balance and Gross Motor Function. Pre data was taken before beginning of treatment and Post data was taken at the end of 3rd week.

2.5 Procedure

The sample of 34 subjects was selected from the population on the basis of inclusion and exclusion criteria. 4 participants were excluded (not meeting the inclusion criteria) and 10 participants were lost to follow up out of 34 participants. Total 20 participants fulfilled the protocol and were equally divided into two groups (Fig. 1). The parents/guardian of subjects who were included in the study was explained about the nature of the study. Pre readings of the Modified Ashworth scale, GMFM-88, pediatric balance scale were taken at baseline i.e. before starting the intervention for both the groups. The treatment protocol of 40min/day for 3 days a week for a period of 3 weeks was given to both groups. After treatment at the end of the 3rd week, Post readings were taken through the Modified Ashworth scale, GMFM-88, Pediatric Balance Scale.

3. INTERVENTIONS

3.1 Group A (Segmental Muscle Vibration + Passive Stretching Exercises)

Children with Cerebral Palsy in Group A received Segmental Muscle Vibration along with conventional treatment i.e. Passive Stretching Exercise. For the Segmental vibration of the muscles, a Hand Vibrator of frequency 50Hz was used as an Intervention [21]. The target muscles i.e. Gluteus Maximus, Gluteus Medius, Biceps Femoris, and Gastrocnemius [20] were given a segmental muscle vibration for five minutes on each muscle with a rest time of one minute in between the muscle. A Passive Stretch of 20 seconds was given on each targeted muscle i.e. Gluteus Maximus, Gluteus Medius, Biceps Femoris, and Gastrocnemius with five repetitions each. 30 Seconds of rest was given in between each muscle after the Passive stretching exercise [22].

3.2 Group B (Pelvic Stabilization Exercises + Passive Stretching Exercises)

Children with Cerebral Palsy in Group B received Pelvic Stabilization Exercise along with conventional treatment i.e. Passive Stretching Exercise. Pelvic stabilization exercises like Clam, leg lift, Tabletop leg lift, Tabletop arm lift, Bridging. Each exercise was given for 10 repetitions for a 10-second hold with assistance. A Passive Stretch of 20 seconds was given on each targeted muscle i.e. Gluteus Maximus, Gluteus Medius, Biceps Femoris, and Gastrocnemius with five repetitions each. 30 Seconds of rest was given in between each muscle after the Passive stretching exercise (Pelvic (hip) Girdle. Exercise Sheet,2018) [23].
The research setting was done in physiotherapy OPD of SGT Hospital and community setting in Gurugram, Haryana and Kota, Rajasthan.

34 subjects were assessed from the population on the basis of inclusion and exclusion criteria.

20 subjects fulfilled the protocol and were divided into two groups.

GROUP A (n=10)
40mins/day, 3 days/week
For 3 weeks

GROUP B (n=10)
40mins/day, 3 days/week
For 3 weeks

1. Segmental muscle vibration
2. Passive Stretching exercises

1. Pelvic stabilization exercises
2. Passive Stretching exercises

Pre data were recorded on the baseline of the study

Post data were recorded at the end of 3rd week of study

Data was collected and analyzed

Fig. 1. Flowchart of demonstrates the experimental design of the study

Fig. 2. Segmental vibration for Gluteus Maximus, Gluteus Medius, Biceps Femoris and Gastrocnemius muscle in spastic CP
3.3 Statistical Analysis

Statistical Analysis was done using software package SPSS 24.00 for window 7 version. The analysis for demographic characteristics was done in frequency and percentage while Wilcoxon test was used to compare mean of data of pre and post intervention within the group and Mann Whitney test was used to compare the mean of data of pre and post intervention in between the group A and B. The p-value<0.05 was considered to be statistically significant.

4. RESULTS

Table 1 shows the comparison of mean and standard deviation (SD) of age among Group A and B. The mean and standard deviation 5.2±0.788 were found in Group A and mean and standard deviation 4.9 ± 0.875 were found in Group B. There was no significant difference of age was found among both Group with t value 0.805.

Table 2 Shows Comparison of Mean value of Modified Ashworth Scale (MAS) at Pre intervention and Post intervention i.e., Baseline and end of 3rd week of subjects within Group A and Group B. In Group A there were significant difference of Gluteus Maximus (p-value 0.025), Biceps Femoris (p-value 0.003) and Gastrocnemius (p-value 0.046) were found in the study with t-value 2.236, 3.00, 2.00 respectively. There was no significant difference of Gluteus Medius (p-value 1.89) with t-value 1.89 was found in the study. Whereas in Group B there was significant difference of Biceps Femoris (p-value 0.014) was found in the study with t-value 2.449. Rest were non-significant.

Table 3 describes the Comparison of means of Muscle Tone (G.max, G.med, Biceps Femoris & Gastrocnemius) of Pre and Post intervention between the group A and B. The mean and standard deviation of pre and post intervention data of Gluteus Maximus 2.65 ± 0.58 and 2.3 ± 0.57, Gluteus Medius 2.55 ± 0.51 and 2.15 ± 0.81, Biceps Femoris 2.15 ± 0.81 and 2.15 ± 0.67, Gastrocnemius 3.55 ± 0.60 and 3.35 ± 0.58 were found between the Group A and B. There was significant difference found in Biceps Femoris of pre and post data (p-value 0.045 and 0.021) with t-value 2.317 and 2.317. Rest was non-significant.
Table 1. Comparison of Mean and Standard Deviation (SD) of Age among Group A and Group B

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Mean</th>
<th>Standard Deviation (SD)</th>
<th>t value</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>Group A</td>
<td>5.2</td>
<td>0.788</td>
<td>0.805</td>
</tr>
<tr>
<td></td>
<td>Group B</td>
<td>4.9</td>
<td>0.875</td>
<td></td>
</tr>
</tbody>
</table>

Fig. 5. Gender Distribution among Group A and B

Table 2. Comparison of t-value and p-value of Modified Ashworth Scale (MAS) at Pre intervention and Post intervention i.e, Baseline and end of 3rd week of subjects within Group A and Group B

<table>
<thead>
<tr>
<th>MAS</th>
<th>Group A</th>
<th>Group B</th>
<th>t value</th>
<th>P value</th>
<th>t value</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>G Max. Pre (Baseline vs Post (end of 3rd Week))</td>
<td>2.236</td>
<td>0.025</td>
<td>1.414</td>
<td>0.157</td>
<td></td>
<td></td>
</tr>
<tr>
<td>G Med. Pre (Baseline vs Post (end of 3rd Week))</td>
<td>1.89</td>
<td>0.059</td>
<td>1.732</td>
<td>0.083</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biceps Femoris Pre (Baseline vs Post (end of 3rd Week))</td>
<td>3.00</td>
<td>0.003</td>
<td>2.449</td>
<td>0.014</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gastrocnemius Pre (Baseline vs Post (end of 3rd Week))</td>
<td>2.00</td>
<td>0.046</td>
<td>0.0</td>
<td>1.000</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 3. Comparison of Mean value of Modified Ashworth Scale (MAS) at Pre intervention and Post intervention i.e, Baseline and end of 3rd week of subjects between Group A and Group B

<table>
<thead>
<tr>
<th>MAS</th>
<th>Group A vs Group B</th>
<th>Mean±SD</th>
<th>t value</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre (Baseline)</td>
<td></td>
<td>2.65 ± 0.58</td>
<td>0.559</td>
<td>0.576</td>
</tr>
<tr>
<td>G Med.</td>
<td></td>
<td>2.55 ± 0.51</td>
<td>0.438</td>
<td>0.661</td>
</tr>
<tr>
<td>Biceps Femoris</td>
<td></td>
<td>2.15 ± 0.81</td>
<td>2.007</td>
<td>0.045*</td>
</tr>
<tr>
<td>Gastrocnemius</td>
<td></td>
<td>3.55±0.60</td>
<td>1.834</td>
<td>0.067</td>
</tr>
<tr>
<td>Post (end of 3rd Week)</td>
<td></td>
<td>2.3 ± 0.57</td>
<td>1.535</td>
<td>0.125</td>
</tr>
<tr>
<td>G Med.</td>
<td></td>
<td>2.15 ± 0.81</td>
<td>0.846</td>
<td>0.397</td>
</tr>
<tr>
<td>Biceps Femoris</td>
<td></td>
<td>2.15 ± 0.67</td>
<td>2.317</td>
<td>0.021*</td>
</tr>
<tr>
<td>Gastrocnemius</td>
<td></td>
<td>3.35 ± 0.58</td>
<td>0.559</td>
<td>0.576</td>
</tr>
</tbody>
</table>
Table 4. Comparison of t-value and p-value of Pediatric Balance Scale at Pre intervention and Post intervention i.e, Baseline and end of 3rd week of subjects within Group A and Group B

<table>
<thead>
<tr>
<th>Pediatric balance scale</th>
<th>Group A</th>
<th>Group B</th>
</tr>
</thead>
<tbody>
<tr>
<td>t-value</td>
<td>p-value</td>
<td>t-value</td>
</tr>
<tr>
<td>Pre (Baseline) vs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Post (end of 3rd Week)</td>
<td>2.821</td>
<td>0.005*</td>
</tr>
</tbody>
</table>

Table 5. Comparison of Mean value of Pediatric Balance Scale at Pre intervention and Post intervention i.e, Baseline and end of 3rd week of subjects between Group A and Group B

<table>
<thead>
<tr>
<th>Pediatric Balance Scale</th>
<th>Group A vs Group B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean ± SD</td>
<td>t-value</td>
</tr>
<tr>
<td>Pre (Baseline)</td>
<td>33.70 ± 5.19</td>
</tr>
<tr>
<td>Post (end of 3rd Week)</td>
<td>38.15 ± 4.62</td>
</tr>
</tbody>
</table>

Table 6. Comparison of t-value and p-value of GMFM-88 at Pre intervention and Post intervention i.e, Baseline and end of 3rd week of subjects within Group A and Group B

<table>
<thead>
<tr>
<th>GMFM-88</th>
<th>Group A</th>
<th>Group B</th>
</tr>
</thead>
<tbody>
<tr>
<td>t-value</td>
<td>p-value</td>
<td>t-value</td>
</tr>
<tr>
<td>Pre (Baseline) vs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Post (end of 3rd Week)</td>
<td>2.803</td>
<td>0.005*</td>
</tr>
</tbody>
</table>

Table 7. Comparison of Mean value of GMFM-88 at Pre intervention and Post intervention i.e, Baseline and end of 3rd week of subjects between Group A and Group B

<table>
<thead>
<tr>
<th>GMFM-88</th>
<th>Group A vs Group B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean ± SD</td>
<td>t-value</td>
</tr>
<tr>
<td>Pre (Baseline)</td>
<td>72.99 ± 6.60</td>
</tr>
<tr>
<td>Post (end of 3rd Week)</td>
<td>75.42 ± 6.90</td>
</tr>
</tbody>
</table>

5. DISCUSSION

Spasticity was considered a primary limiting impairment in people with cerebral palsy [24]. According to various studies many interventional experiments were conducted to reduce spasticity and to improve associated factors, in neurological condition like, cerebral palsy. The present study was conducted to find out the effect of segmental muscle vibration and pelvic stabilization exercises on spasticity and gross motor function in spastic cerebral palsy. The data was collected pre and post intervention i.e. before and after 3 weeks. Age group of 4-6 years was taken in the study and subjects were equally
distributed into two groups i.e. Group A and Group B. Gender Distribution in Group A were 60% male and 40% females and in group B 50% male and 50% were females.

5.1 Role of Segmental Vibration and Pelvic Stabilization Exercise in Improving Muscle Tone in Spastic Cerebral Palsy

The comparison of mean value within the Group A and B was done. The statistically difference between the t-value and p-value at baseline Vs end of 3rd week i.e., for Gluteus Maximus, Gluteus Medius, Biceps Femoris & Gastrocnemius were 2.236, 1.89, 3.00, 2.00 and 1.414, 1.732, 2.449 and 0.0 for group A and B respectively. It reveals that there was a significant difference for Gluteus Maximus, Biceps Femoris & Gastrocnemius in group A. The result achieved from the comparison between the mean value of MAS Score between Group A and Group B at Pre and Post Intervention i.e., Baseline and end of 3rd week was 2.65 ± 0.58 and 2.3 ± 0.57 and, 2.55 ± 0.51 and 2.15 ± 0.81, 2.15 ± 0.81 and 2.15 ± 0.67, 3.55 ± 0.60 and 3.35 ± 0.58 for Gluteus Maximus, Gluteus Medius, Biceps Femoris & Gastrocnemius respectively. The comparison of mean value between Group A and Group B was done, the statistically difference between the t-value and p-value at Pre and Post Intervention i.e., Baseline and end of 3rd week was 0.559 and 1.535, 0.438 and 0.846, 2.007 and 2.317, 1.834 and 0.559 respectively. It reveals that there was a significant difference of Pre and Post Intervention i.e., Baseline and end of 3rd week 0.045 and 0.021 for Biceps Femoris and rest were found non-significant. Park C. et al. [20], Caliandro P. et al. [16], Katusic A. [18] were also found that there significant effect of vibration therapy on tone (spasticity).

5.2 Role of Segmental Vibration and Pelvic Stabilization Exercise in Improving Balance in Spastic Cerebral Palsy

The comparison of mean value within the Group A and B at baseline Vs end of 3rd week were 2.821 and 2.803 respectively. It reveals that there was a significant difference between the baseline and end of 3rd week scores within the groups. And comparison of mean value between Group A and Group B was done, the statistically difference between the t-value and p-value at baseline Vs end of 3rd week were 1.146 60 and 0.00. It reveals that there was no significant difference for balance between Group A and Group B were found. El-Shamy SM, [25], Dudoniene V. et al. [26], Saquetto M. et al. [27] were found that there were significant effect of vibration therapy on balance in the study.

5.3 Role of Segmental Vibration and Pelvic Stabilization Exercise in Improving Gross Motor Functions in Spastic Cerebral Palsy

The comparison of mean value within the Group A and B was done, the statistically difference between the t-value and p-value at baseline Vs end of 3rd week 2.803. It reveals that there was a significant difference between the baseline and end of 3rd week scores within groups. The comparison of mean value between Group A and Group B was done, the statistically difference between the t-value and p-value at baseline Vs end of 3rd week were 0.756 and 0.605. It reveals that there was no significant difference for Gross Motor Function between balance of Group A and Group B were found. (p value ≥ 0.05). Katusic A. et al. [18] Dudoniene V. et al. [26], Jung Y. et al. [28] concluded that vibration stimuli are significantly improves Gross motor performance in children with Cerebral Palsy.

Present experimental study of three weeks was proved significant improvement in spasticity, balance and gross motor function in both the groups. The result of above study supporting the hypothesis that treatment through segmental vibration therapy with conventional treatment would lead to reduction in spasticity, improvement in balance and gross motor functions.

Ruck. et al. [15] had demonstrated that vibration therapy is safe and has some effect on mobility in children with cerebral palsy, but there still is a need of standardized methods. Ibrahim et al. [29] in their study also found that the vibration therapy decreased spasticity and improve motor functions after 12 week treatment program.

The present study has explained that when using Segmental vibration therapy in combination with conventional interventions like stretching, muscle tone, mainly, improved more significantly than with exercises alone in spastic hemiplegic cerebral palsy. This was also supported by Tavernese et al. [30], who reported that the use
of SMV on the Biceps Brachii and Flexor Carpi Ulnaris of the affected side of their participants who had suffered a stroke, along with physical therapy, produced a significant improvement in normalized jerk and reaching motion and this effect was maintained at the participants’ 2-week post treatment evaluation. In summary both group have shown significant improvement in balance and gross motor function. But group A has shown more significant reduction in spasticity. Hence segmental vibration therapy has shown significant improvement in variables given in the study.

6. CONCLUSION
The present study suggested that in children with spastic hemiplegic cerebral palsy both the Segmental Vibration Inhibition Therapy and Pelvic Stabilization exercise yielded a clinically significant improvement; but Segmental Vibration Inhibition Therapy shows more improvement in reduction in tone, improvement in balance and gross motor function.

7. LIMITATION(S)
Very limited Age group was included in the study. Intervention is used on limited muscles and for short duration of interval and Treatment protocol. Home Exercises were not prescribed, the Sample size was small (subjects were lost from the study because of Covid-19 pandemic) and no post treatment follow up was done.

8. FUTURE RECOMMENDATION(S)
Future research is needed to evaluate the effect of segmental muscle vibration therapy on large sample size with proper home exercise program. Age group range should be increase in future study with long treatment protocol that means more than 3 weeks.

ETHICAL APPROVAL
The Institutional Ethical Clearance of SGT university Faculty of Physiotherapy was obtained prior to the study (Ethical Number: SGTU/FOP/2020/36).

CONSENT
Assessment of the participants was taken after the written consent was signed by the parents/guardian of the participants.

COMPETING INTERESTS
Authors have declared that no competing interests exist.

REFERENCES


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