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Original Research Article

The Effect of Selective Voluntary Motor Control Training of Lower Limb on Gait and Activities of Daily Living of Children with Spastic Cerebral Palsy: Randomized Controlled Trial

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ABSTRACT

Context: Voluntary movement is produced by the corticospinal tracts. Injury to CST (periventricular white matter) leads to motor disability in Cerebral Palsy (CP). Selective Voluntary Motor Control is vital for efficient locomotion & functional activities.
Aims: To find the efficacy of improving Selective Voluntary Motor Control of the Lower limb on Gait and Activities of Daily Living children (ADL) with spastic Cerebral Palsy.
Settings and Design: Occupational Therapy Department of Tertiary Health Care Centre, Prospective, Interventional, Comparative, Single-blinded, Randomized Control Trial.
Methods and Material: 32 CP children were ethically recruited and using a simple random sampling method were divided into 2 groups. Each subject was assessed using standardized tools: Modified Ashworth scale (MAS), Selective Control Assessment of Lower Extremity (SCALE), Observational Gait Scale (OGS), Wee-Functional independence measure (Wee-fim), Case-Record Form on day 1, 30th, and 60th.
Statistical analysis used: Data were entered using MS-EXCEL Office 365, SPSS Statistical Software version 23.0 was used for data analysis and non-parametric tests of significance were used. Results: 28 Subjects completed the study. Post-intervention SCALE and OGS scores showed a positive correlation in the Control group(r2=0.104) and the Experimental group(r2=0.244). From baseline-day 60 SCALE and Wee-fim showed a correlation r2=0.463-0.022 in the Experimental group and r2=0.426-0.051 in the Control group. Overall, the experimental group showed better improvement in gait and ADL than the control group.
Conclusions: SVMC training of the lower limb was effective & has a positive impact on the performance of Gait. Thus, it improves functional independence.
Key Messages: Understanding the influence of impaired Selective Voluntary Motor Control helps Occupational Therapists in being an important part of decision-making regarding therapeutic problem solving, splint prescription, muscle selection for Botox, muscle transfers, and surgery in a multidisciplinary team of rehabilitation.

Keywords: Activities of Daily Living, Cerebral palsy, Gait, Selective motor control.

INTRODUCTION

In India, 15-20% of children with disability are affected by Cerebral Palsy (CP) with estimated 3/1000 live births.[1] Cerebral Palsy is a neurological disorder caused by a non-progressive brain injury or malformation.[2] Spastic CP has spasticity is one of the impairments present. It is further classified as spastic- monoplegia, hemiplegia, diplegia, and quadriplegia.[3]

Normal selective voluntary motor control (SVMC) is defined as the ability to perform isolated joint movement without using mass flexor/extensor patterns. [4]

Voluntary movement is produced through the cortico-spinal tracts (CSTs). Injury to CST within the periventricular white matter has been correlated with motor disability in CP.[5] It has been long identified that SVMC is vital for efficient locomotion and skilled function activities. [6,7]

Studies suggest that in children with CP, dependence on daily activities is due to dependent mobility. The improvement of mobility is an important objective of rehabilitation.[6,7] The literature review shows a variety of medical and therapeutic treatments for CP. As in standard occupational therapy, the emphasis is more on gross motor skills, lesser attention is given to selective control[8,9] Hence, this study tried to project the effect of selective voluntary motor control training along with standard Occupational therapy in gait and performance in daily living functions by following the protocol described in the methodology.

The study aims at finding the efficacy of improving SVMC of the Lower limb on Gait and Activities of Daily Living in children with spastic CP.

The objectives of this research were to study the efficacy of SVMC training of the Lower limb in improving Gait and ADL in Children with Spastic CP. Assess children for spasticity using Modified Ashworth Scale (MAS), motor control of lower limb using Selective Control Assessment of Lower Extremity (SCALE), gait using Observational gait scale (OGS), and performance in Activities of daily living using Wee-FIM scale pre-and post-intervention. Correlate pre-post intervention scores of Motor control (SCALE) with those of Gait (OGS) and Activities of daily living (Wee-FIM).

LITERATURE REVIEW

J.Y. Zhou, E. Lowe, et al. (October 2018)[10] conducted a study on Influence of impaired selective motor control on gait in children with cerebral palsy. The study was carried out on 57 children with bilateral spastic Cerebral palsy, between the age group of 7 to 11 years. The study concluded on impaired SMC predicts increased knee flexion at initial contact and reduces step length and velocity. Understanding the influence of impaired SMC on gait can inform decisions regarding therapy and surgery, such as hamstring lengthening. Observational analysis indicates that impaired SMC can slow the transition from stance phase hip and knee extension to swing phase hip and knee flexion, leading to gait asymmetry and poor foot clearance in swing, which can also reduce step length.

Curtis DJ, et al. Dev Neuro rehab (Feb 2018) [11] conducted a study on the "functional effect of segmental trunk and head control training in moderate-severe cerebral palsy" which was a randomized controlled trial done on 28 participants to determine whether segmental training is more effective in improving gross motor function than conventional physiotherapy. The study concluded that segmental training was not superior to usual care in improving GMFM. Improvements in head and trunk sway were greater in the segmental training group at primary endpoint but not at follow-up.

Kyeongwon Kim and Jin Young Kang (May 2016) [7] conducted a study to find "Relationship Between Mobility and Self-Care Activity in Children With Cerebral Palsy" on 63 cerebral palsy children between the ages of 4 and 18 years This study investigated factors that were associated with self-care activities and found that mobility is a significant factor in self-care activities of CP children aged =7 years. The study concluded that in CP children aged less than 7 years, mobility was the only significant factor influencing independence of self-care activities. The results suggest that mobility development rather than gross motor development is important in developing self-care activity in children aged ≥7 years old. Hence, a rehabilitation program aimed at improving mobility is crucial in children with CP aged ≥7 years, since it forms the basis for further improvements in self-care activity, leading to significant improvements in the quality of life.

Ko I-H, Kim J-H, Lee B-H. (Jan 2014)[12] conducted a study on" Relationship between Lower Limb Muscle Structure and Function in Cerebral Palsy" to provide information for intervention by comparing lower limb muscle thickness, gross motor function, and functional level of activity daily living between cerebral palsy (CP) and mental retardation (MR) on 60 subjects: 38 cerebral palsy,9 mentally retarded, and 13 normally developing infants. The study concluded that CP and MR subjects had smaller muscle thicknesses and Strengths than those of normally developing infants, and lower gross Motor function and functional independent level. In cerebral palsy, this is because of spasticity in the muscle which results in pseudo atrophy. Also, Cerebral palsy children showed limitations in basic ability of movement which appeared as lower scores in the items of standing, walking, and running in GMFM. Limitations of functional activity were shown by both groups of children in the Wee-FIM.

Elaine fowler (September 2008)[13] conducted a study on the Effect of lower extremity selective voluntary motor control on inter-joint coordination during gait on 15 children with spastic diplegic Cerebral palsy (CP). Significant correlations were found between SCALE scores and both MRP values ($p < 0.0001$) and duration of out-of-phase movement ($p < 0.005$) during swing. These findings supported that SVMC ability is related to a patient's ability to move in an uncoupled pattern during the swing phase of gait (i.e., extending the knee while flexing the hip). Conclusion: An understanding of influence of SVMC on swing phase gait mechanics may help establish appropriate goals for interventions, in particular, hamstring lengthening

MATERIALS & METHODS

The study was approved by the Institutional Ethics Committee as a Prospective, Interventional, Comparative, Single Blinded, Randomized Control Trial study and was completed in 18 Months

Sample Size:

Sample size calculation is done by using the mean baseline WEE-FIM Scale score for the patient with Spastic CP, the WEE-FIM score was 90±4 with conventional occupational therapy, and the expected increment in the score was 94±4 after using selective voluntary motor control training of lower limb along with conventional occupational Therapy is needed to evaluate the intervention. So, to detect a 4SD difference between two groups with the statistical significance level of 0.05 with the power of the study of 80%, we found that 32 participants with CP are needed. i.e., 16 participants in each group.

Children diagnosed with Spastic CP referred to the Occupational therapy department of the tertiary health care center for intervention were screened for eligibility. Parents/guardians and the patient have explained the purpose and nature of the study. Those willing to enroll themselves in the study were then asked to sign an informed consent letter (the parents/guardians) and ascent letter participants (≥7 years), in their native language.

The eligibility criteria of the participants:

Inclusion Criteria:

- Children between the age group of 4-8 years are diagnosed with Spastic CP.
- With spasticity grade 1-3 (Modified Ashworth scale).
- Ambulatory with or without orthotics, and assistive devices (GMFCS l-lll).
- Having basic cognitive skills (able to follow simple commands).

Exclusion Criteria:

- Children underwent any casting procedures/Botox injections in the past 6 months.
- Undergone surgical intervention or selective dorsal rhizotomy or receiving intrathecal baclofen in the past 6 months.

Study Procedure: The principal investigator had screened 32 subjects using the inclusion and exclusion criteria and the participants were divided in the following manner:

Method of Selection in Groups: Single Blinding, Simple Randomization sampling technique. i.e., odd, and even were used.[14]16 subjects were randomly enrolled Control group and 16 in the Experimental group. However, there were 4 dropouts from both groups. Control group-2 subjects dropped out due to conflict of timings between school & therapy setup and 1 patient because of traveling inconvenience as the patient had shifted to another state. Experimental group-1 dropped due to Caregiver non-compliance. So, the study was done on 28 participants. [fig no. 1]

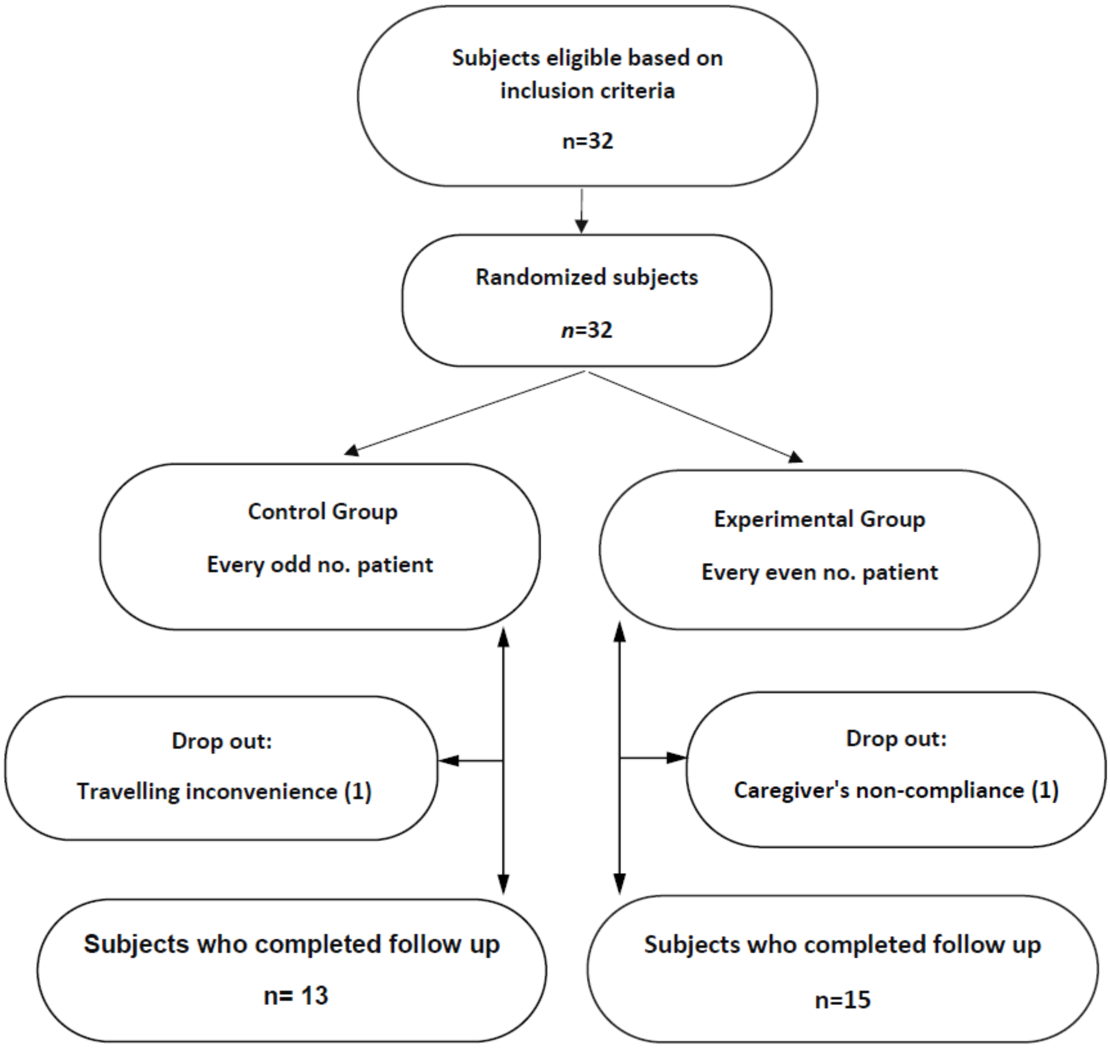


Fig no. 1: The flowchart below explains the reasons for the total number of participants completing the study

Assessment And Evaluation Protocol

Investigator performed baseline evaluation using assessment tools which included

1. The Case Record Form: Demographics, milestones and primitive reflexes, and neurological evaluation.
2. Modified Ashworth Scale: for assessment of spasticity.

3. Selective Control Assessment of Lower Extremity: for assessment of selective voluntary motor control of lower extremity.
4. Observational Gait Scale score: for assessment of gait.
5. Wee-Functional Independence Measure: to assess the level of assistance in activities of Daily Living performance.

As the intervention protocol was for 8 weeks (twice a week), the assessment was done on day 1, day 30th, and day 60th of the protocol. Time for each assessment:30-45 minutes.

Outcome Measures:

Primary outcome measures:

The Selective Control Assessment of The Lower Extremity[15]:

It requires 15 minutes without specialized equipment. Each joint is scored 2, 1, or 0 points. These are summed for a Total Limb Score.

Wee-Functional Independence Measure [16,17]

It measures functional abilities and the need for assistance associated with the level of disability in children ages between 6 months-7 years and older. 18 items have been divided into 6 areas. Performance is rated on a 7-level ordinal rating system ranging from 7(complete independence) to 1 (total assistance). The total rating ranges from 18-to 126

Observational Gait Scale [18,19]

It seeks to evaluate or measure the amount of change in an individual's gait pattern over time. It has 8 sections for scoring both the Left and Right lower extremities. A total score is 22 for each limb.

Secondary Outcome measure

Modified Ashworth Scale [20,21]

Five-point ordinal scale for grading the resistance encountered during passive muscle stretching.

Therapy Protocol

Each group received 2 sessions of therapy per week for 45 minutes each session and a home program.

The Control Group was subjected to a Standard Occupational therapy program that focused on Rood's techniques [9], Bobath's techniques [10], and play-based therapy divided equally within 45 minutes of the session.

The experimental group was subjected to SVMC training of the lower limb and a Standard Occupational Therapy program, which focused on lower limb selective voluntary motor control exercises for the last 15 mins of the session and exercises like the Control group for the first 30 minutes of the session.

Exercises which were common for both the Groups: Normalization of tone- Using Rood's and Bobath's Technique to achieve relaxation of the muscles. Exercises focused on the improvement of trunk control, strengthening, stability, and mobility e.g., Reach-outs. Gait training- Using adaptive devices, equipment, and visual and auditory cues. Performance of simulated functional task, last part of the sessions was an explanation of the home program

Details About Selective Voluntary Motor Control Training

The protocol was based on neuro-musculoskeletal components and focused on controlled lower limb motion along with a standard occupational therapy program. Activities allowing the joint to move selectively in a repetitive rhythmic manner promoting dissociation of the movements were given. [Table no.1] Mirror movements, mass patterns of flexion and extension 'synergies,' and involuntary movement at other joints including the contralateral limb were avoided. Initially, 3 sets of 10 repetitions of activities were given actively at each joint and passively where no active movements were seen. Based on the improvement of each patient, resistance was added in the form of a weighted cuff, heavy medicine ball, increased resistance in the cycle, etc. to promote strengthening.

Table no. 1: Selective Voluntary motor control Activities given in the Experimental group

Joint	Position	Activity		
		Minimal resistance	**Moderate resistance**	**Maximum resistance**
Hip	Side-lying Target lower limb in knee extension & other which is close to the ground in knee flexion	Forward and backward rolling of the lightweight ball.	Forward and backward moving of skateboard or rolling board.	Kicking the heavy medicine ball. [Fig no. 2]
Knee	Sitting Hip and knee at 90° flexion & ankle in a neutral position	Dynamic quadriceps table without weight.	Medicine ball kicking in sitting position.	Dynamic quadriceps table without weight. [Fig no. 3]
Ankle	Long-Sitting Maintaining a neutral position at the knee	Touching the ball with the dorsum of the foot & sole. i.e. moving the foot close to the ball. [Fig no. 4 & 5]	Pumping a small therapy ball with the movement of plantar & dorsiflexion	Medicine ball kicking in sitting position.
Subtalar	Sitting Maintaining a neutral position at the knee and ankle joint	Moving a light ball from left to right and vice-versa maintaining a neutral position at the knee and ankle joint	Kicking a hanging ball in a sitting position involves eversion and inversion movement of the ankle.	Moving heavy medicine ball in the pattern mentioned above
Toes	Sitting Hip & knee flexed at 90° & ankle in the neutral position	Toe curls with cloth in sitting with hip and knee flexed at 90 degrees and ankle in the neutral position	Moving small naphthalene balls with toes	Moving TheraBand of moderate to maximum resistance

2a

2b

Fig no. 2: Active movement at the hip without compensation at the hip.
2a: minimal resistance(top); 2b: maximum resistance(bottom)

3a

3b

Fig no.3a & 3b: Dynamic knee extension without compensation at hip and ankle without resistance [left image] and with resistance [right fig]

Statistical Analysis

For statistical analysis, assessment of scores of outcome measures was done on Day 1 (baseline), 30 days, and 60 days of intervention. The data was entered using MS-EXCEL Office 365 and was analyzed using SPSS Statistical Software version 23.0.

Following non-parametric tests of significance were used as data did not follow a normal distribution.

Friedman's Two-way ANOVA test: for assessing the statistical significance of two successive assessments (baseline, 30th day & 60th day) of the experimental and control group over two related samples for total scores of each outcome measure.

Mann Whitney U test: for assessing the statistically significant difference between the medians in two unrelated groups i.e., experimental and control groups for total scores of each outcome measure pre & post-intervention.

The Spearman's rank correlation test: for assessing the association or relationship between two unrelated variables in each population data and to measure if their association is statistically significant or by chance. The P-value less than 0.05 was taken as statistically significant at a 95% confidence level.

RESULT

A total of 28 participants completed the study. Maximum participants (46.7%) were between the age group of 4-5years in the experimental group. In control,30.8 % of participants were between 4-5years and 30.8 % between 7-8yrs. The Control group had 8 female and 7 male subjects while the experimental group had 7 female and 8 male subjects.

The experimental group had 7 diplegics, 4 right & 3 left hemiplegics while, in the Control group 6 diplegic, 4 right, and 6 left hemiplegics completed the study. Overall hemiplegics were more than diplegics (17/28).

Friedman's test showed a significant difference($p<0.05$) in the reduction of MAS scores (.i.e., of spasticity) of hip flexor & adductor of left-lower limb in the experimental group, ankle dorsiflexors, plantar-flexors, evertors & invertors of both lower limb in both groups with significantly more in experimental group participants between day 1 and day 60 of follow up & knee flexors on right-lower limb in the experimental group. Also, there was no increase in spasticity seen in any muscle group following the intervention.

Friedman's Two-way ANOVA test reported that there was a significant difference($P<0.05$) between the baseline and day 30, Day 60 post-intervention SCALE Score, OGS score & Wee-FIM Score within the experimental group as well as a control group.

Findings using the Mann Whitney test revealed no statistically significant difference($p=.751$) between median pre-intervention scores of SCALE measure and, OGS among both groups.

There was a statistically significant difference of p value=0.015 at day 30 & p value=0.000 at day 60 amongst control and experimental between the median post-intervention SCALE Score as seen in table no. 2. Statistically significant difference of 0.011 on day 30 & 0.004 on day 60 between the median post-intervention total OGS scale amongst the control and experimental group. (Table no.3)

Findings of Wee-fim Score for both groups revealed no statistically significant difference (p-value=0.821) between the median pre-intervention total WEE-FIM Score at baseline, also p-value compared for both the groups showed no statistical difference(p-value=-.525) between the median post-intervention total WEE-FIM Score post day 30 and day 60 amongst both group (Table no. 4).

The correlation was done between pre-post intervention SCALE & OGS scores, using spearman's rho correlation coefficient presented Scatter plot showing positive correlation in the Control group ($r2=0.514$) and Experimental Group ($r2=0.571$). However, in the control group from baseline to day 60 this significant correlation decreased(r2=0.104), while in the experimental group(r2=0.244) it did not decrease as much as that of controls (Graph no.1a and 1b).

Correlation done between pre-post intervention SCALE & Wee-FIM scores (graph no. 2a and 2b), using spearman's rho correlation coefficient presented Scatter plot showing that in the control group from baseline to day 60 significant positive correlation between scale score and Wee-FIM score disappeared (from r2=0.463 to r2=0.022) while in experimental group significant positive correlation decrease (from r2=0.426 to r2=0.051) but not as much as the control group.

Table no. 2: Intergroup comparison of Pre- and Post-intervention median scores of Selective control Assessment of lower extremity between control and experimental group.

Test	Score at Baseline	Score on Day 30	Score on Day 60
Mann-Whitney U	90.000	45.500	22.000
Wilcoxon W	210.000	136.500	113.000
Z	-.350	-2.424	-3.530
Asymp. Sig. (2-tailed)	.727	.015	.000
Exact Sig. [2*(1-tailed Sig.)]	.751b	.015b	.000b
Significance	Not significant	Significant	Significant

A Mann Whitney test reported that the difference between median pre-intervention total Scale

The score among the control and experimental group was not statistically significant while there was a statistically significant difference between the median post-intervention total Scale Score at day 30 amongst the control and experimental group. Also, there was a statistically significant difference between the median post-intervention total Scale Score at day 60 amongst the control and experimental group.

Table no. 3 Comparison of Pre- and Post-intervention median scores of Observational Gait Scale between control and experimental group.

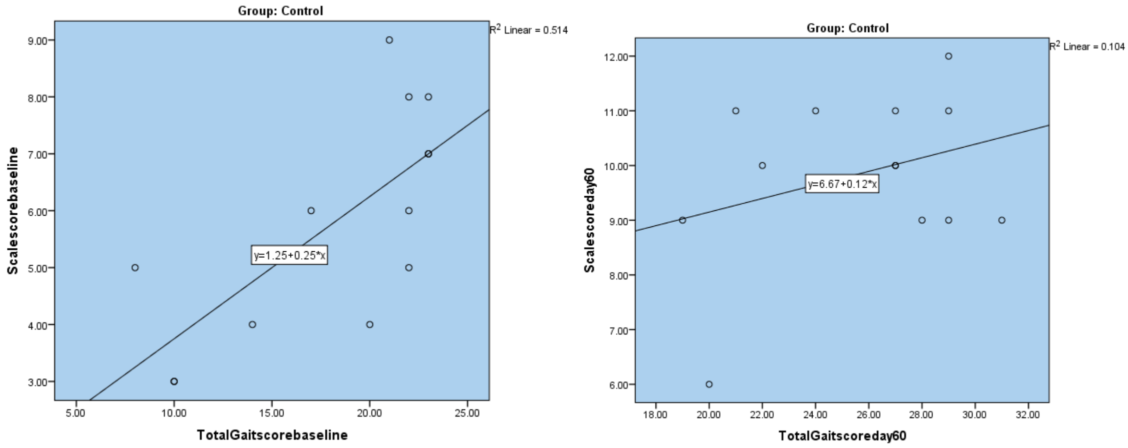
Test	Score at Baseline	Score on Day 30	Score on Day 60
Mann-Whitney U	86.000	43.000	36.500
Wilcoxon W	177.000	134.000	127.500
Z	-.533	-2.522	-2.818
Asymp. Sig. (2-tailed)	.594	.012	.005
Exact Sig. [2*(1-tailed Sig.)]	.618b	.011b	.004b
Significance	Not significant	Significant	Significant

A Mann-Whitney test reported that the difference between the median pre-intervention total Gait Score among the control and experimental group was not statistically significant while there was a statistically significant difference between the median post-intervention total Gait Score at day 30 between the control and experimental group. Also, there was a statistically significant difference between the median post-intervention total Gait Score at day 60 between the control and experimental group

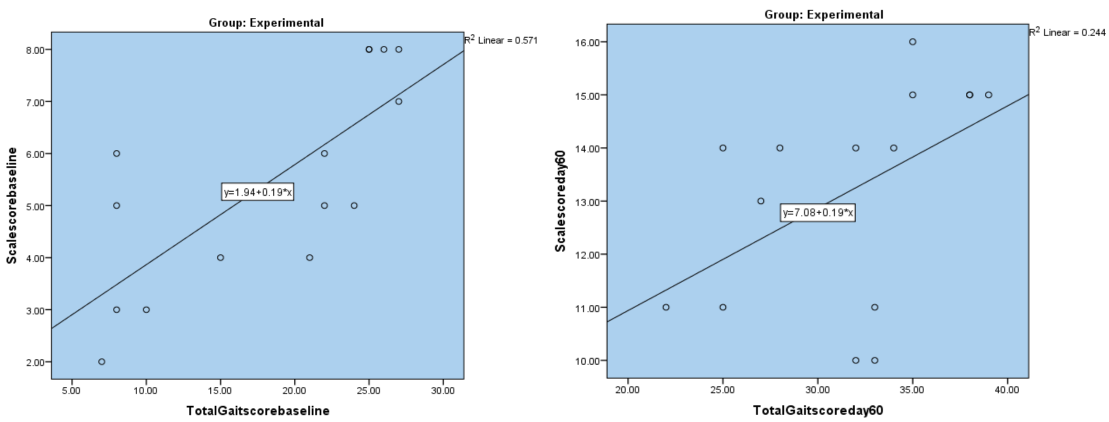
Table no. 4 Comparison of Pre and Post-Intervention median scores of Wee-FIM between control and experimental group.

Test	Score at Baseline	Score on Day 30	Score on Day 60
Mann-Whitney U	92.500	82.500	83.000
Wilcoxon W	183.500	173.500	174.000
Z	-.231	-.692	-.669
Asymp. Sig. (2-tailed)	.818	.489	.504
Exact Sig. [2*(1-tailed Sig.)]	.821b	.496b	.525b
Significance	**Not significant**	**Not Significant**	**Not Significant**

A Mann-Whitney test reported that the difference between the median pre-intervention total WEE-FIM Score among the control and experimental group was not statistically significant while there was a statistically significant difference between the median post-intervention total WEE-FIM Score at day 30 amongst the control and experimental group. Also, there was a statistically significant difference between the median post-intervention total WEE-FIM Score at day 60 amongst the control and experimental group

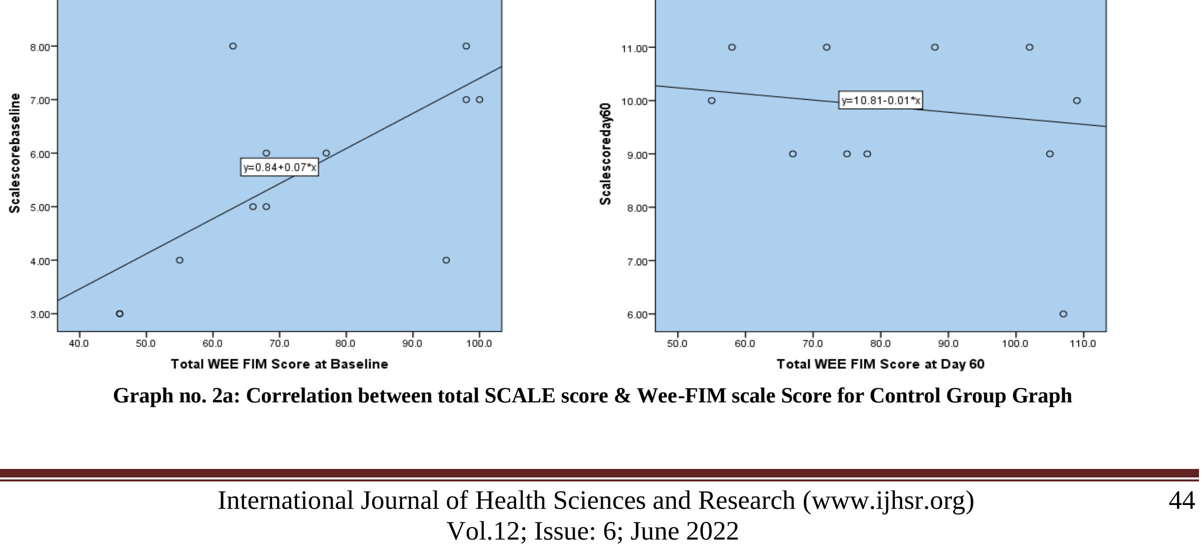


Graph no. 1a: Correlation between total OGS score & total SCALE score for control group indicating decline in correlation post-intervention

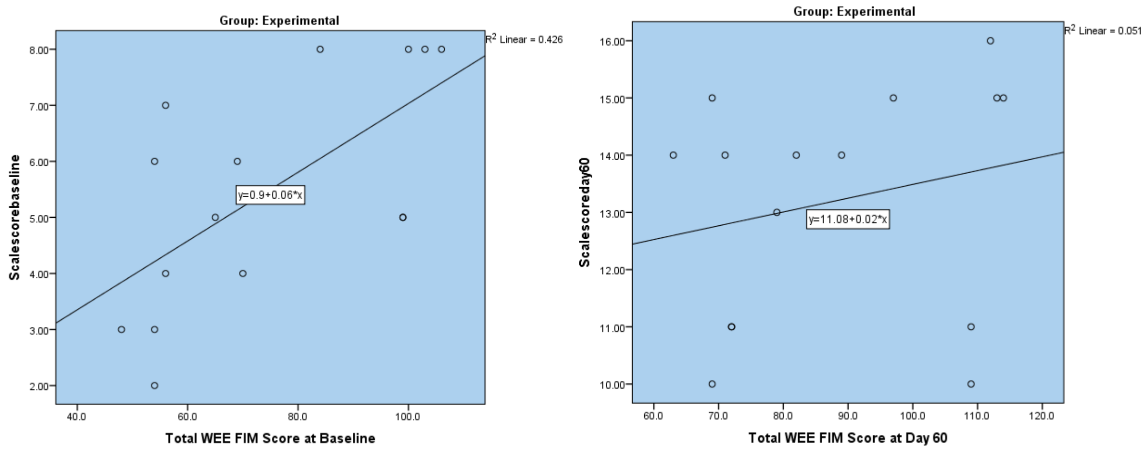


Graph no. 1b: Correlation between total gait score & total scale score at experimental group indication no reduction in correlation

The above scatter plot shows that there was a positive correlation seen in both the groups between the SCALE score and OGS score. However, in the control group from baseline to day 60 significant correlation between gait score and scale score decreased, while in the experimental group it didn't decrease as much as that of the controls



Graph no. 2a: Correlation between total SCALE score & Wee-FIM scale Score for Control Group Graph



Graph no. 2b: Correlation between total SCALE score & Wee FIM scale Score for Experimental group

We see from the above scatter plot that in the control group from baseline to day 60 significant correlation between scale score and Wee-FIM score disappeared while in the experimental group from baseline to day 60 significant correlation between SCALE score and Wee-FIM score decreased but not as much as the control group

DISCUSSION

28 subjects completed the intervention. Most of the participants were between the age group of 4-5yrs. The reason being subjects coming to the tertiary pediatric occupational therapy unit are from this age group. The present study had hemiplegics more than diplegics (17 and 11 respectively). “Epidemiology of cerebral palsy” by Else Odding and Marij states that because of the increase in survival proportion of low-weight infants, the proportion of Diplegic CP has decreased while the proportion of hemiplegic CP has increased.[22]

MAS score of the experimental group revealed a reduction in spasticity more than that of the control group because along with roods and neurodevelopmental training, the intervention involved the use of rhythmic repetitive exercises like stationary cycling and kicking the ball. A similar reduction in spasticity was found in a study conducted by Jeffery M. on adolescents with CP. Reduction in the spasticity is attributed to the joints' isotonic repetitive exercises, which were proven to have an impact on spasticity.[23]

Earlier there was a notion that strength training increases spasticity. However, this was questionable because of no increase in spasticity in our study. Eileen flower, et al showed that there was no increase in spasticity following exercises on 24 spastic diplegia children. Concluding resistance and strength training do not affect the spasticity of patients with mild to moderate impairment and spasticity [24], which was also seen in the subjects that were involved in our study.

SCALE score

The Post-intervention p-value was significant enough to state that SVMC training of lower extremities along with OT program was better and faster in improving functional outcomes among subjects than Standard OT program only. Improvement in the Experimental group was observed as exercises focused on rhythmic repetitive movements like cycling and strengthening exercises, which are considered to have a positive impact on Selective motor control. A study conducted by Yasuaki K. on 40 Spastic Diplegic CP children showed a difference in the SVMC of the bilateral lower extremities, and the lower extremity SVMC was related to maximum knee extensor strength.[25] Our study included a specific protocol for strengthening the lower extremity in a selective motor pattern. As the strength of the lower extremity muscles improved, improvement was seen in the SVMC as shown in table 2.

OGS Score

Improvement in the gait parameter like decrease in recurvatum, increase in the base of support, initial foot contact, foot contact at midstance, and timing of heel rise was seen in the Experimental group. Indicating improvement seen in SVMC of the lower limb. The reason behind this was a significant improvement in the strength of hip flexors, extensors & abductors, knee flexors ankle dorsiflexor, and invertors of subjects involved in the study. While, in the control group, there was a slight improvement seen in the strength of hip flexors, extensors, invertors, and knee extensor muscles. Therefore, improvement was seen in gait parameters- base of support foot initial foot contact and contact of the foot at midstance.

The result indicates that both intervention methods proved to be effective in improving gait with better improvement seen in the experimental group. After the 4th and 8th weeks of intervention, the p-value of both the groups was significant to state that the combination of SVMC Training and the Standard OT program was better in improving the gait outcome among CP subjects than the Standard OT program [table no. 3]. OGS scale assigned to check for the change in gait showed a difference in both the groups.

Thompson N, et al. conducted a study to identify the effect of muscle strength and walking abilities on 50 ambulant children with spastic diplegia CP(the mean age-11 years 7 months). The greatest difference in strength between independent walkers & dependent walking aids is in the hip abductors and knee extensors at 30o, which are key muscle groups in the sagittal and coronal plane of walking stability. This has implications for targeting strength training to maximize functional outcomes. [26]

Our findings were consistent with the study conducted by Shelley A. et al. on 15 community-dwelling stroke survivors to identify the effect of “Isokinetic Strength Training of the Hemiparetic Knee”. The result showed that tone remained consistent ($p > X7$). Gait velocity increased after training ($p < .05$) and at follow-up ($p < .05$) although subjects perceived gains in their physical abilities at follow-up ($p <.01$). Concluded that there were gains in strength and gait velocity after a short-term strengthening program for stroke survivors.[27]

K. Cahill-Rowley et al study to identify the relationship between impaired SMC and gait was assessed using multivariate linear regression analysis of Selective Control Assessment of the Lower Extremity (SCALE) about stance phase knee flexion and temporal-spatial gait parameters calculated using 3D kinematics for 57 children with bilateral spastic CP, ages 7-11 years. Results showed that impaired SMC predicts increased knee flexion at initial contact and reduces step length and velocity.[4]

Correlation between SCALE and OGS Scores

After the intervention, there was a better positive correlation between selective motor control and gait score in the experimental group. Eileen G. Fowler et al showed that SVMC ability is related to a patient’s ability to move in an uncoupled pattern during the swing phase of gait. SVMC on swing phase gait mechanics may help establish appropriate intervention goals, particularly hamstring lengthening. [24] Research by J. Y. Zhou et al revealed that impaired SMC predicts increased knee flexion at initial contact and reduces step length and velocity.[11]

The above study findings can correlate with our results that improved the Selective voluntary motor Experimental group more than the Control Group as shown in table 8a & 8b. In the future, a large sample size would be needed to find an accurate strong correlation.

Wee- FIM scores

Both intervention methods proved to be equally effective in improving functional independence in ADLs of subjects from maximal/moderate assistance to minimal/modified independence. After the 4th & 8th weeks of intervention, the p-value compared for both groups A and B showed no statistical difference. This indicates that the combination of SVMC and Standard OT program was as effective to improve functional independence among CP subjects as only the Standard Occupational therapy program. Wee-FIM scale being attributed to seeing the difference between functional independence levels showed no difference in both the groups. Improvement in the pre-post ADL score of the experiment group was because Selective voluntary motor control training focused on active uncoupled movements of the lower limb which led to an increase in the mobility [improved OGS score] and self-care tasks involving the lower limb.

Analysis of a retrospective study, done on 25 CP children aged ≥4 years by Kyeongwon et al. showed that PEDI mobility is the only factor significantly influencing PEDI self-care ($R2=0.875$, $p=0.03$). Findings were similar to our study, stating that mobility is essential for independence in self-care. The mobility Score increased post-intervention in the Experimental group because of improved SVMC of the lower extremity. The Wee-FIM score of the experimental group was better than the control.[7] As the focus of the protocol in the Experimental group was on lower limb selective motor control, activities of daily living that required upper extremity like eating, and dressing upper extremity showed minimal change in independence compared with the score change of mobility.

Correlation between SCALE and Wee-FIM scores

A better positive correlation between SCALE & Wee-FIM score was seen in the experimental group after the intervention, but the correlation was very weak(r2=). As activities of the Experimental group focused on the lower extremity selective control, mobility, & self-care component score of Wee-FIM showed more improvement than the cognitive component, therefore the score of Wee-FIM did not increase to the extent of the SCALE Score. But the correlation in the control group disappeared as gross motor activities were given, indicating the need to work on Selective Voluntary motor Control. Evidence shows improvement in gross motor control has a positive effect on functioning. However, there is a lack of evidence on the association between Wee-FIM & Selective motor Control.

In our study, subtypes of CP were included and the post-intervention working status of the subjects from both groups revealed that hemiplegics showed better improvement than diplegics. So, individualized improvement in patient post-intervention could be attributed to the type of CP & their age. This can be correlated with the research conducted by Damiano on 11 CP children, where hemiplegics showed better improvement than diplegics on after muscle strengthening intervention [28]

A combination of an overview of prior research & findings of the current study provides evidence that the combined effect of SVMC training with the Standard Occupational therapy program was more effective than the Standard Occupational therapy Program only, in CP subjects to improve gait.

This study provides insight into the assessment & treatment of lower extremity SVMC impairments in a sample of the CP population in India.

CONCLUSION

SVMC training of lower limb was effective & has a positive impact on the performance of Gait. Thus, it improves functional independence. It helps to identify & rehabilitate specific problems related to motor control of Cerebral Palsy. Better improvement was observed in younger children compared to older ones. It helps to prove that structured & goal-directed programs should be initiated in younger kids rather than waiting for the kid to grow & learn basic gross motor skills first.

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