International Journal of Health Sciences and Research
Vol.12; Issue: 5; May 2022
Website: www.ijhsr.org
Original Research Article *ISSN: 2249-9571*

Effect of Sensory Integration Therapy on Gross Motor Function in Children with Spastic Diplegic Cerebral Palsy: A Pilot Study

Neelam K Rathod[1], Shraddha Diwan[2], Palak M Engineer[3]

[1]Lecturer & I/C Principal at Arush Physiotherapy College, Shahibaug, Ahmedabad - 380004, Gujarat, India
[2]Lecturer at S.B.B. College of Physiotherapy, V.S. General Hospital,
Ellis Bridge, Ahmedabad-380006, Gujarat, India
[3]Lecturer at Khyati Institute of Physiotherapy, Shahibaug, Ahmedabad - 380004, Gujarat, India

Corresponding Author: Neelam K Rathod

DOI: https://doi.org/10.52403/ijhsr.20220507

ABSTRACT

Background: Spastic Diplegic CP is bilateral spasticity in the legs and less severely in the arms and face although the hands may be clumsy. Sensory Integration Therapy is one of the rehabilitative approaches that was originally developed by A. Jean Ayres American Occupational Therapist in the 1970s.They defined Sensory Integration as "the neurological process that organizes sensation from one's own body and from the environment and make it possible to use the body effectively within the environment". The aim of present study was to find out the comparative effect of therapist guided SIT Vs. Home based programme on gross motor function in children with spastic diplegic cerebral palsy.
Method: An experimental study was done with convenient sampling .12 children with spastic diplegic CP age between 2-6year & GMFCS I, II, III selected and divided in to 2 groups, group A (treatment group) & group B (control group). Each session of duration was kept 45-60 min, 4-5 days per week for a period of 2 month for group A and for group B SI Home bound activities were explained. Gross motor function measurement (GMFM 88) and sensory profile caregiver questioner (SPCQ) were taken in each of them. Statistical analysis was done using SPSS version 16.
Results: After 2 month of intervention showed significant improvement in GMFM dimensions D (p= 0.041) & E (p=0.043) in group A and in group B showed significant improvement in GMFM dimension D (p=0.041). Between groups comparison after 2 month showed significant improvement in dimension E (p=0.050).
Conclusion: SIT can improve the gross motor function in children with spastic diplegic cerebral palsy with addition to NDT. SIT can help to improve Sensory performance related to endurance, improve grasp, reduced fear of fall from the heights, improve from whole day sedentary plays activities & enjoy movement activities.

***Keywords*:** Sensory integration therapy, Spastic diplegic cerebral palsy, SPCQ, GMFM, GMFCS.

INTRODUCTION

Cerebral palsy (CP) is described as a group of permanent disorders of the development of movement and posture, causing activity limitations, which are attributed to non-progressive disturbances that occurred in the developing fetal or infant brain. The motor disorder of cerebral palsy is often accompanied by disturbances of sensation, perception, cognition, communication and behavior, by epilepsy, and by musculoskeletal problems [1, 2].
Cerebral palsy is clinically classified as spastic, athetoid, ataxic, and hypotonic; the most prevalent form is spastic CP [3], which affects motor and postural development and which causes sensory disorders and learning disabilities.[4] There are an estimated over 25

lakh children and people in India with Cerebral Palsy. The incidence of Cerebral Palsy is up to 3 cases per 1000 live births. [5]

Spastic Diplegic CP is bilateral spasticity in the legs and less severely in the arms and face (although the hands may be clumsy). Common neuro-motor limitations are bilateral movement disorder, Spasticity more evident in lower extremity & decreased postural tone in the trunk as well as sensory processing deficits affect more to the vestibular, tactile and visual system. Children with vestibular processing disorder found Gravitational insecurity and decreased response to linear vestibular input, Tactile processing disorder found Increased or decreased response to tactile input while handling, Tactile discrimination problem-2 point and Poor stereognosis, and Visual motor, visual perceptual difficulties.

Sensory integration.[7,8,9] Ayres defined sensory integration as "the neurological process that organizes sensation from one's own body and from the environment and make it possible to use the body effectively within the environment". Ayres postulated that sensory integration dysfunction occurs when sensory neurons are not signaling or functioning efficiently, leading to deficits in development, learning, and/or emotional regulation.

Sensory integration therapy (SIT) is one of the rehabilitative approaches that were originally developed by A. Jean Ayres American Occupational Therapist in the 1970. SIT focuses on desensitizing and helping the person recognize sensory information. The goal of intervention is to improve the child's ability to process and integrate sensory information as a basis for enhanced independence and participation in daily life activities, play and school tasks.[6, 7]

SIT is an active therapy, and the activities usually involve the use of large pieces of equipment such as big rolls and balls, trampolines, swinging hammocks, which provide intense proprioceptive, vestibular and tactile experiences [10,11,12]. It is a process occurring in the brain that enables the child to make sense of their world by receiving, registering, modulating, organizing and interpreting the information that comes to their brains from their senses. SIT helps to overcome problems experienced by many young children in absorbing and processing sensory information. Encouraging these abilities ultimately improves balance and steady movement [13].

NDT & SIT both have theoretical explanations to reduce the problems of impaired movement & coordination in the children with CP but there is scarcity of right to find out effect of SIT. So, the purpose of present study is to examine the additional effect of SIT on gross motor function in children with spastic diplegic CP.

Will a child who is receiving sensory integration therapy five days per week for two months, in conjunction with his/her regular NDT programming, show a positive change on development of gross motor function?

METHOD

Twelve children with spastic diplegic cerebral palsy coming from various OPDs of V S General Hospital to pediatric rehabilitation department of SBB college of physiotherapy. Inclusion criteria were diagnosis of CP (patient's diagnosis of CP confirmed by an expert pediatrician and a neurologist), age between 2 -10 years with GMFCS I, II, III and children who able to follow 2 step of verbal command were selected.

Children were excluded if they had diagnosis of other neuro-developmental disorders, mental retardation, seizures, patient with learning disability, Receipt of medical procedures likely to affect motor function such as botulinum toxin injections, orthopaedic remedial surgery within six months.

A convenience sample was used. Ethical approval was granted for the study and informed written consent statements were signed by all the parents. Baseline

characteristic matched according to age, gender & GMFCS level in both the groups. One standardized validated measure of function was used: The GMFM (GMFM-88) is a clinical measure designed to assesses gross motor abilities of children with CP in five dimensions: (1) Lie and Roll, (2) Sit, (3) Crawl and Kneel, (4) Stand, (5) Walk, Run, and Jump 14,15. In children with CP, the GMFM has been shown to be sensitive to change during periods of therapy.16, 17, 18 This measure has been studied for its reliability and validity 14. A child's sensory processing abilities checked by sensory profile caregiver questionnaire (SPCQ) via structured interview.

Then Participants were divided into two groups. There was (n=6) children in each group. In the group A children were treated by SIT in the clinical set up with their regular NDT treatment and in the control group B all children and parents explained and taught SI activities for home with their regular NDT in clinical setup. Home bound activities diary was given for regular follow up. The treatment was conducted in one institutional Centre for all participants.

Therapy Duration was kept 4 or 5 times per week for 2 months, each session being 45-60 minute. Prior to start the therapy baseline data of outcome measures GMFM & SPCQ was measured. Then data was analyzed after the one month of interventions and after completion of two month.

All kind of precautions taken during intervention likes the suspensions system of all equipment was checked prior to the therapy session, the floor beneath the suspended equipment was covered fully by mats in order to prevent accidental fall & injury, Intervention was given in quite SI room without any distractible noise during intervention, One secondary Therapist was appointed along with primary therapist for safety measures.

Activities like Walking up and down on a big wedge, Bouncing up and down on a trampoline, Hanging on trapeze bar and crash in to ball pool, Activities providing linear movement, activities involving suspended equipment done in a variety of position, Sitting or standing on bolster swing (swing that are hang from two suspension points), Standing on platform swing and move in linear direction, Lying prone enhances proprioception because of the need to resist gravity to hold head and legs given for Treatment of sensory modulation dysfunction, Gravitational insecurity, for aversive response to movement activities given that provide linear movement (vestibular) and resistance to active movement (proprioception) help to minimize aversive responses, Treatment for poor sensory discrimination.

Targeting processing related to semicircular canal: Fast swinging- provide input to semicircular canals, Activities that involve picking up balls from mat or throwing at suspended objects while swinging. Walking on different texture mats for treatment of decreased discrimination of tactile sensation.

Treatment for improving posture: Developing tonic postural extension: activities like Swinging prone over a swing or working in prone on elbow, throwing activities during swinging in a prone position and for developing tonic postural flexion activity like forward reach outs during swinging given.

Home bound activities likes Small indoor trampoline on which the child can jump or with use of 2 or 3 home mats and jump on it, standing on swing set and Forward and sideway swinging at home or in the garden, Forward and sideway reach out with use of toy or ball during swinging, Walking on slop at home or in the garden, Walking on different textured doormats at home or waking on grass and sand in the garden taught to parents.

The statistical analysis was done using SPSS version 16. Before applying statistical tests, data was screened for normal distribution. All the outcome measures were analyzed at baseline, after 4 week and after 8 week of treatment. Level

of significance was kept at 5%. Changes in outcome measure were analyzed within group as well as between groups. Within group comparison was analyzed by Wilcoxon sign rank test and between group comparisons was analyzed by using Mann Whitney U test.

RESULTS

Overall, twelve children completed the complete duration of the treatment for 8 weeks.

Demographic descriptions of study participants are given in table no 1.

Within group comparison was done by using non parametric Wilcoxon sign rank test. mean and standard deviation (SD) of comparison between pre and after 4 week GMFM with three dimensions values of C, D and E for group A given in table 2. In the C dimension of crawling and kneeling and D dimension standing p value were >0.05 showing no significance difference after 4 week of intervention.in the E dimension walking, running & jumping p value < 0.05 showing significant difference after 4 week of intervention.

Table 1: Demographic description of study participants

Groups	Age (2-6 year)		Gender		GMFCSLEVEL		
	Mean	SD	Boy	Girl	I	II	III
Group A(n=6)	5.1	1.83	5	1	0	5	1
Group B(n=6)	5.1	2	4	2	0	4	2

Table 2: Mean score of GMFM C, GMFM D, GMFM E after 4 week within group A

GMFM	PRETREATMENT		AFTER4 WEEK		Z value	p value
	Mean	SD	Mean	SD		
C	88.53	1.52	89.28	1.50	-1.342	0.180
D	46.14	2.33	56.40	2.80	-1.826	0.068
E	37.26	2.38	47.21	2.50	-2.023	**0.043**

Mean score of comparison between pre and after 8 week GMFM with three dimensions values of C, D and E for group A given in table no 3. Wilcoxon sign rank test showed in the C dimension p value was >0.05 showing no significance difference in this component after 8 week of intervention and in the D & E dimension p value < 0.05 showing significant difference after 8 week of intervention.

Table 3: Mean score of GMFM C, GMFM D, GMFM E after 8 week within group A

GMFM	PRETREATMENT		AFTER8 WEEK		Z value	P value
	Mean	SD	Mean	SD		
C	88.53	1.52	90.87	1.17	-1.604	0.109
D	46.14	2.33	64.50	2.81	-2.041	**0.041**
E	37.26	2.38	53.00	2.94	-2.023	**0.043**

Table 4: Mean score of GMFM C, GMFM D, GMFM E after 4 week within group B

GMFM	PRETREATMENT		AFTER4 WEEK		Z value	p value
	Mean	SD	Mean	SD		
C	74.20	2.62	74.20	2.62	0.00	1.00
D	51.27	2.43	53.84	2.43	-1.604	0.109
E	40.73	2.44	41.43	2.44	-1.342	0.180

Table 5: Mean score of GMFM C, GMFM D, GMFM E after 8 week within group B

GMFM	PRETREATMENT		AFTER8 WEEK		Z value	p value
	Mean	SD	Mean	SD		
C	88.53	2.62	74.59	2.53	-1.000	0.317
D	46.14	2.43	55.97	2.40	-2.041	0.041
E	37.26	2.44	42.12	2.47	-2.121	0.060

Table 4 shows mean score of comparison between pre and after 4 week GMFM with three dimensions values of C, D and E for group B. In the C, D and E dimension value were
>0.05 showing no significance difference after 4 week.

Table 5 shows mean score of comparison between pre and after 8 week GMFM with three dimensions values of C, D and E for group B. In the C dimension and E dimension walking, running & jumping p value were >0.05 showing no significance difference in these dimension after 8 week. In the D dimension standing p

value < 0.05 showing significant difference after 8 week.

Table 6: Between two group comparison of GMFM Dimensions C, D & E

Between2groupcomparison						
GMFM Dimension	Group A		Group B		Uvalue	p value
	Mean	SD	Mean	SD		
C	2.34	3.68	0.39	0.97	12.00	0.252
D	18.37	1.83	4.70	2.99	10.00	0.195
E	15.14	1.60	1.39	0.88	6.00	**0.050**

Post treatment comparison was done by using non parametric unpaired samples Mann Whitney U Test. In the C & D dimension P value was > 0.05 showing no significance difference between two groups. p value for E dimension were < 0.05 showing significant difference between two group comparison.

Table 7: Within group comparison of response score to various components on the sensoryprofile (GROUP A)

SECTION		GROUP A				Z Value	p Value
		Baseline		After 4th week			
		Mean	SD	Mean	SD		
A	Auditory Processing	30	6.85	30.16	5.84	0.000	1.000
B	Visual Processing	40.5	4.31	39	3.10	-0.813	0.416
C	Vestibular Processing	49	4.28	51.33	2.86	-1.084	0.279
D	Touch Processing	77.5	9.10	76	8.75	-0.946	0.344
E	Multisensory Processing	25.66	3.34	24.16	5.20	-0.368	0.713
F	Oral sensory processing	50.33	2.98	51.66	3.77	-1.342	0.180
H	Modulation Related to BodyPosition and Movement	33.16	6.33	36.16	4.56	-0.943	0.345
G	Sensory Processing Relatedto Endurance/Tone	29.66	6.20	34.16	6.87	-2.032	0.042
I	Modulation of MovementAffecting Activity Level	20.5	5.53	26.16	3.80	-2.032	0.042
J	Modulation of Sensory Input Affecting Emotional Responses	13.33	2.98	13.83	2.73	-1.134	0.257
K	Modulation of Visual Input Affecting Emotional Responses	15.5	0.76	15.83	0.37	-0.816	0.414
L	Emotional/Social Responses	70	8.44	77.83	9.65	-1.604	0.109
M	Behavioral Outcomes ofSensory Processing	18.16	3.93	18.33	3.77	-0.577	0.564
N	Items Indicating Thresholdsfor Response	12.33	2.74	14.16	1.21	-1.604	0.09

Table 8: Within group comparison of response score to various components on the sensory profile (GROUP A)

Section	GROUP A				Z Value	P Value
	Baseline		After8thweek			
	Mean	SD	Mean	SD		
A	30	6.85	33.83	3.38	-1.826	0.068
B	40.5	4.31	41.66	2.92	-1.289	0.197
C	49	4.28	52.33	2.28	-1.633	0.102
D	77.5	9.10	80.5	5.5	-1.214	0.225
E	25.66	3.34	26.66	6.87	-0.946	0.344
F	50.33	2.98	57.5	4.23	-2.203	0.043
H	33.16	6.33	37.16	4.77	-1.153	0.249
G	29.66	6.20	34	8.44	-1.892	0.058
I	20.5	5.53	27	6.21	-1.997	0.046
J	13.33	2.98	14.83	1.34	-1.473	0.141
K	15.5	0.76	15.55	0.37	-1.342	0.180
L	70	8.44	71.33	8.93	-2.207	0.027
M	18.16	3.93	21	5.19	-2.041	0.041
N	12.33	2.74	14.16	1.21	-1.841	0.066

Table 9: Within group comparison of response score to various components on the sensoryprofile (GROUP B)

Section	GROUPB				Z Value	P Value
	Baseline		After 4th week			
	Mean	SD	Mean	SD		
A	35	3	35.5	2.56	-0.378	0.705
B	38.16	5.39	39.66	4.30	-1.633	0.102
C	52	5.85	53.83	1.67	-0.535	0.593
D	82.16	6.38	82.33	5.70	-0.272	0.785
E	25.83	4.74	28.66	2.28	-1.890	0.059
F	58	1.63	58.83	1.21	-1.633	0.102
G	29.66	4.49	30.33	5.02	-1.134	0.257
H	37.83	4.74	39.5	4.68	-1.826	0.068
I	22.66	6.28	24.16	6.93	-1.846	0.066
J	13.33	4.26	13.66	4.38	-1.604	0.109
K	14.66	2.21	15.5	1.11	-1.342	0.180
L	69.5	6.72	71.33	7.38	-1.483	0.138
M	22.33	3.54	25.16	2.03	-1.841	0.066
N	11.66	3.39	13.66	1.97	-1.095	0.273

Table 10: Within group comparison of response score to various components on the sensory profile (GROUP B)

SECTION	GROUPB				Z Value	P Value
	Baseline		After 8th week			
	Mean	SD	Mean	SD		
A	35	3	36.16	2.73	-1.414	0.157
B	38.16	5.39	39.83	4.56	-1.604	0.109
C	52	5.85	53.83	1.67	-0.535	0.593
D	82.16	6.38	84.16	4.41	-1.089	0.276
E	25.83	4.74	29.66	2.42	-2.032	0.042
F	58	1.63	58.66	1.49	-1.414	0.157
G	29.66	4.49	30.33	5.02	-1.604	0.109
H	37.83	4.74	41.83	2.85	-1.826	0.068
I	22.66	6.28	24.66	6.59	-2.060	0.039
J	13.33	4.26	15.33	2.98	-1.846	0.066
K	14.66	2.21	15.5	1.11	-1.342	0.180
L	69.5	6.72	73.5	8.5	-1.753	0.080
M	22.33	3.54	25.33	1.88	-1.841	0.066
N	11.66	3.39	14.5	1.11	-1.473	0.141

Above table 7 shows significant difference ($p<0.05$) in section G & I Section of the SPCQ withingroup A pre and after 4th week of intervention.

Above table 8 shows significant difference ($p<0.05$) in section G, I, L & M Section of the SPCQ within group A pre and after 8th week of intervention.

Above table 9 shows significant difference ($p<0.05$) in section E Section of the SPCQ within group B pre and after 4th week of intervention

Above table 10 shows significant difference ($p<0.05$) in section E & I Section of the SPCQ within group B pre and after 4th week of intervention

Table 11: Between group comparisons of SPCQ section analysis

Between 2groupcomparison						
SPCQ Section	Group A		Group B		U value	p value
	Mean	SD	Mean	SD		
A	3.83	4.66	1.5	1.22	14.00	0.511
B	1.16	1.60	0.66	0.81	16.00	0.730
C	2	2.20	0.87	0.98	12.50	0.357
D	3.66	4.23	2.33	3.82	14.00	0.510
E	5.83	4.35	3.50	5.20	11.00	0.253
F	7.33	4.98	4.98	0.94	5.00	**0.029**
G	6.33	5.87	5.87	3.94	8.00	0.104
H	4	7.72	3.5	3.98	14.50	0.574
I	7.33	6.02	2.00	1.26	5.00	0.065
J	1.83	2.40	2	2.82	18.00	1.000
K	0.16	0.37	0.83	1.21	14.00	0.400
L	7.33	7.63	4	5.06	14.50	0.574
M	2.83	2.40	2.40	3.41	17.00	0.871
N	3.83	3.93	2.83	3.76	14.00	0.511

Between group comparison of SPCQ section shows significant difference in section F (oral sensory processing)

DISCUSSION

Improvement of gross motor function is one of the most important aims of treating children with CP. Various therapy methods have been applied to obtain normal motor development, to prevent postural abnormalities, sensory defenses, gross motor dysfunction and deformities and to increase functional capacity in children with CP. [9,10,19 ,22,23]

The treatment group A that received SIT, according to GMFM 88 score abilities in three positions, i.e. (sitting, crawling and standing) showed significantly better improvement than the control group B. However, in the second group that no received home based sensory activities, there was only significant improvement in Crawling ability.

Few studies have investigated the effect of SIT on gross motor function. In a randomized controlled trial by Carlsen, individuals were assigned to either the control group (n=6) or the SIT group

(n=10), which received 2 hours of therapy per week over 6 weeks, the group that received SIT experienced a significantly better improvement in sitting and crawling abilities compared to the control group.[24]

Shamsoddini & M.T. Hollisaz et al (2009) investigated the effect of SIT on gross motor function in children with spastic diplegic cerebral palsy in which (n=27) children with diplegic CP received SIT for 12 weeks, while the control group got home exercise, which includes routine occupational therapy for 12 weeks done by parents and controlled by an occupational therapist. It showed significant improvements in GMFM scores in sitting, crawling and standing positions between the two groups, following SIT. However there were no significant improvements in rolling and walking ability.[9]

Shamsoddini et al (2010) further investigated the significant improvement in lying and rolling, sitting, crawling and kneeling and standing ability. But there was no significant difference in walking, running, and jumping abilities.[7]

SIT programs have been used to facilitate motor functions. Each type of treatment (SIT or NDT) might be expected to yield different changes in motor performance. The SIT approach tries to facilitate normal development and to improve the child's ability to process and integrate sensory information (visual, perceptual, proprioceptive, and auditory, etc.).[25]

The purpose of the Sensory Profile (SP) is to evaluate the contributions of sensory processing to a child's daily functional performance, to determine the child's tendencies to respond to stimuli, and understand which systems is likely contributing or providing challenges to the child's performance.[21]

The treatment group A that received SIT, according to SPCQ data after 2 month of therapy showed significantly better improvement than after 1 month of therapy period. However in the second group that only explained home based sensory Integration activities, there was significant improvement much not better than treatment group.

Comparison of both the groups after 2 month of SIT showed significant difference in Oral sensory processing (Section F). Although SI therapy given as a part of this research was not intended to improve oral function. The found result may be result of parallel speech therapy patient would be taking.

When children have difficulty in a sensory system, it means that this form of sensory input is confusing, upsetting, or not meaningful to the child. In any case, difficulty with sensory input can interfere with child ability to complete important activities as successfully as other children do. Functional problems associated with SMD include decreased social skills and participation in play; decreased frequency, duration, or complexity of adaptive responses; impaired self- confidence; and diminished fine motor, gross motor, and sensorimotor skill development (Bundy & Murray, 2002).[20]

Pouget et al. (2002) and Liu et al (2002) demonstrated the critical role of sensory systems for the generation of spatial maps of motor movements (motor imagery) as well as motor feedback for task execution and adjustment. When disorganization of sensory integration occurs, children miscalculate limb or truncal movements, error with readjustments, and misperceive external signals. As a result, they have difficulty with basic motor activities (walking, running, sitting, writing), and try to develop alternative strategies (e.g. cognitive) for tasks that other children perform 'without thinking.'

The addition of an SI frame of reference to an NDT intervention can improve the quality of not only the motor control but the child's affect, emotional responses and ability to integrate and synthesize information from his body and his environment to make better adaptive responses. Both the approaches improve not only the postural control, coordination and

motor output, as well as improve the sensory processing, believed to be the foundation for developing core behavioral and emotional regulation; develop the ability to regulate one's arousal and attention and improve motor planning needed to be effective in daily life.

Limitation:
Study was done with small sample size.

Future recommendation:
Sensory issues and gross motor functional measure can be assessed according to the different type and characteristics of the cerebral palsy with large sample size.

CONCLUSION

SIT can improve the gross motor function in children with spastic diplegic cerebral palsy with addition to NDT. SIT can help to improve Sensory performance related to endurance, improve grasp, reduced fear of fall from the heights, improve from whole day sedentary plays activities & enjoy movement activities.

Acknowledgements: Authors want to express deep sense of gratitude to all the subjects and their parents who participated in the study and spent their valuable time.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval:
Ethical approval was obtained from institute review board SBB College of Physiotherapy, Ahmedabad, Gujarat, India.

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How to cite this article: Neelam K Rathod, Shraddha Diwan, Palak M Engineer. Effect of sensory integration therapy on gross motor function in children with spastic diplegic cerebral palsy: a pilot study. *Int J Health Sci Res.* 2022; 12(5):48-56. DOI: *https://doi.org/10.52403/ijhsr.20220507*

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