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## Effectiveness of Sensory Integration Therapy on Gross Motor Function in Spastic Diplegic Cerebral Palsy Children



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### ABSTRACT

**INTRODUCTION:** Cerebral palsy (CP), a common, non-progressive, but not necessarily unchanging neurological disorder of childhood. Spastic diplegia, the most prevalent form of CP, is characterized by motor in-coordination, primarily in the lower extremities, that impairs many functional abilities, most notably ambulation. The evidence supporting the effectiveness of sensory integration therapy on gross motor function in spastic diplegic CP is scarce. **METHODS:** 30 Children, both males and females, diagnosed with diplegic spastic CP were taken from Department of Paediatrics, GGS Medical College and Hospital and OPD, University College of Physiotherapy, Faridkot, Punjab. Children were randomly divided into two groups: Group A (n=15) and Group B (n=15) with age 3 to 7 years. All children were evaluated with Gross Motor Function Measurement (GMFM - 88) scale for rolling, sitting, crawling, standing and walking dimensions and for spasticity with Modified Ashworth Scale (MAS) at the beginning and follow up was done at the end of 2<sup>nd</sup> and at the end of 4<sup>th</sup> month one hour/day with 5 days/week for 4 months. Group A received conventional physiotherapy and Group B received sensory integration therapy along with conventional physiotherapy. **RESULT:** Gross motor function in Group B improved significantly ( $P < 0.05$ ) better than in Group A, after intervention in rolling ( $P = 0.03$ ), sitting ( $P = 0.0$ ) and crawling ( $P = 0.21$ ) positions; however no significant difference was seen in standing ( $P = 0.303$ ) and walking ( $P = 1.00$ ) using independent t- test. MAS scores showed significant improvements in reducing spasticity with significance  $p = 0.003$  ( $p < 0.05$ ) in both groups but the mean of Group B = 0.76 showed more marked decrease in spasticity than that of Group A = 2.00. **CONCLUSION:** This study showed the significantly positive effect of sensory integration therapy on gross motor function in spastic diplegic CP children.

## INTRODUCTION

“Cerebral palsy describes a group of permanent disorders of the development of movement and posture, causing activity limitation that is attributed to non-progressive disturbances that occurred in the developing fetal or infant brain. The motor disorders of cerebral palsy are often accompanied by disturbances of sensation, perception, cognition, communication, behaviour, epilepsy and by secondary musculoskeletal problems” [8].

Cerebral palsy affects males and females in equal numbers [5]. Worldwide; the prevalence of cerebral palsy is reported to be between 2–2.5 per 1000 live births according to many studies. The incidence of cerebral palsy in United Kingdom is 2.4 per 1000. It varies between 1.5 and 1.8 per 1000 in the USA. It is 1 per 1000 in France and 1.7 per 1000 live births in Sweden [1].

Sensory integration refers to the process by which the brain organizes and interprets external stimuli such as touch, movement, body awareness, sight, sound, and gravity. It occurs in the brain context and requires balance between the central and peripheral nervous system as well as between excitatory and inhibitory neurological systems [3, 6].

Problem in sensory integration leads to sensory integration dysfunction (SID) which is defined as " the inefficient neurological processing of information received through senses causing problems with learning, developmental and behaviour” [10]. Sensory integration dysfunction is thought to impair the vestibular, proprioception and tactile systems. One approach to help children with CP achieve their optimal level of functioning is Sensory Integration Therapy (SIT). Jean Ayres defines the construct of sensory integration as " the neurological process that organizes sensation from one's own body and from the environment and makes it possible to use the body effectively within the environment" [2]. It appears that cerebral palsy children share an abnormal degree of sensory processing, whether decreased or increased. Its aim is to provide the child with graded sensory experiences. It 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. So, Sensory integration therapy (SIT) is designed to restore effective neurological processing and increase the individual ability to integrate sensory information by enhancing

each of these sensory systems [4]. The aim of this study was to investigate the effectiveness of the sensory integration therapy on gross motor function in spastic diplegic cerebral palsy children.

## **MATERIALS AND METHODS**

### **Design:**

Randomization was done by simple random sampling. After baseline assessment, parents of children drew one of 30 pre-printed cards in opaque sealed envelopes from a box (15 labelled 'group A' and 15 labelled 'group B') and were placed in the intervention in accordance with the card drawn. The parents of eligible children were duly informed of the rationale and procedure for the study and were enlightened about the aim of the research in improving physiotherapy services to children with CP.

### **Children, therapist and centres:**

Out of 40 children referred to the physiotherapy OPD, 30 children with spastic diplegic CP were selected from a population of children, who had been followed up at University College of Physiotherapy, Faridkot, Punjab.

Inclusion criteria were: Children of both genders were taken, age groups between 3-7 years, previously diagnosed as diplegic cerebral palsy. Exclusion criteria were: Children who were waiting for surgery or has had previous surgery of the foot, leg, or ankle; other conflicting concurrent treatment, such as plaster casts, Orthoses, BONT-A injection, Baclofen pump or other treatment effecting neuromuscular transmission at any other point prior to investigation; prior orthopedic surgery; any of the following diagnosis: Hemophilia, Myasthenia gravis, Eaton-Lamberts syndrome; children with subluxation or dislocation of hip, fracture of spine or limbs, severe scoliosis, seizures, mental retardation, fixed contractures and any other congenital deformity.

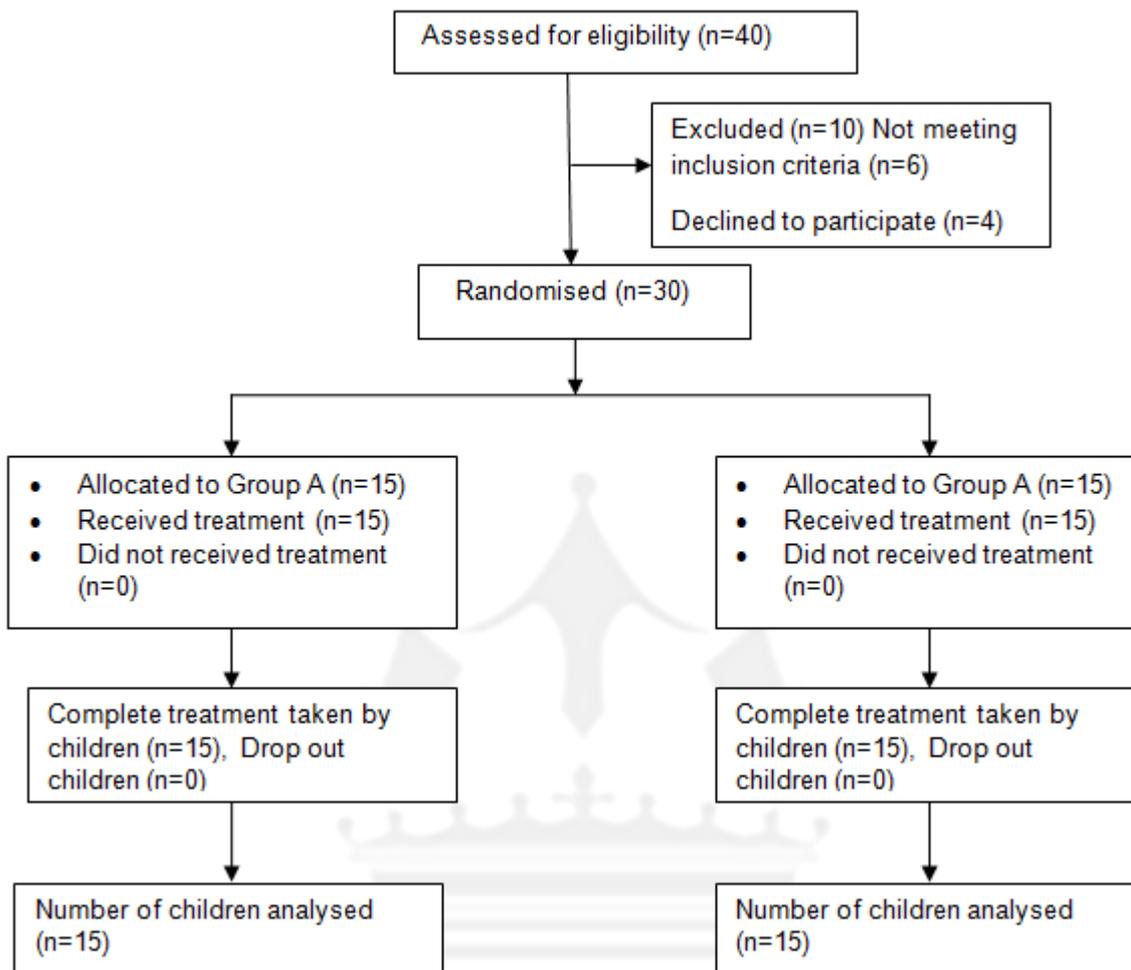
Children were divided into a Group A and Group B by randomization. Gross motor function of children was evaluated according to Gross Motor Function Measure (GMFM-88) scale and spasticity with Modified Ashworth scale (MAS). The Group B received and participated in sensory integration treatment plus conventional physiotherapy for 4 months, while the Group A got conventional physiotherapy alone, which includes routine passive range of motion exercises, stretching exercises for 4 months performed by physiotherapist on children.

Assessments at 0<sup>th</sup> month, at end of 2<sup>nd</sup> month, and at end of 4<sup>th</sup> month treatment were undertaken by one physiotherapist.

**INTERVENTION:** In this study, the children were treated one hour/day with 5days/week for 4 months. The Group B underwent sensory integration therapy plus conventional physiotherapy. In each session, exercises and the following activities were completed by Group B;

Sensory integration therapy: Visual perception activities: Block design, finding shapes in pictures, puzzles, matching geometric shapes and letters, numbers, and classification; Body awareness: Pointing to the body parts, life-size drawing, turning left and right side and awareness of the body parts through touch; Tactile perception: Feeling various textures, touching boards and feeling shapes; Visual-motor coordination training: Ocular-pursuit training, moving ball and pegboard activities [15]. Conventional physiotherapy: Passive stretching exercises, Passive range of motion exercises.

The Group A underwent the conventional physiotherapy alone. The Independent sample t-test used for comparison of initial measurements in the two groups revealed no significant differences in 5 dimensions ( $p > 0.05$ ). Independent sample t-test used for comparison of scores between two groups. The intervention mean scores at 0<sup>th</sup> month, at end of 2<sup>nd</sup> month and at end of 4<sup>th</sup> month for each of the two groups were analysed using a paired-sample t-test, to determine whether there were any significant differences. Statistical analysis was performed with SPSS (version 20), with P-values less than 0.05 considered statistically significant.



**Figure 1. Flow Chart of Treatment Procedure**

**OUTCOME MEASURES:** All assessments were done at 0<sup>th</sup> month after randomization, at end of 2<sup>nd</sup> month, and at end of 4<sup>th</sup> month treatment by physiotherapist. The Standardized validated measure of function were used: The GMFM (GMFM-88) is a clinical measure designed to assess 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. This measure has been studied for its reliability and validity [15].

The modified Ashworth scale [12] attempt to measure the severity of hypertonia using clinical assessment scales. A study was conducted with  $n = 30$ , mean age = 59.3 (17.6) years, patients with central nervous system lesions found excellent inter-rater reliability using MAS between two experienced raters (Kendall's tau = 0.847,  $p < 0.001$ ) [13].

**DATA ANALYSIS AND RESULTS:** Overall 30 children completed the complete duration of the treatment for 4months. 15 in Group A ( 6 females, 9 males, age range 3-7 years; mean

age 4.86 years) and 15 in Group B (5 females, 8 males, age range 3-7 years; mean age 5.0 years).

Independent t-test was performed for inter group comparison between Group A and B to analyse the changes in gross motor function and muscle tone at 0<sup>th</sup> month to end of 2<sup>nd</sup> month, at end of 2<sup>nd</sup> month to end of 4<sup>th</sup> month and 0<sup>th</sup> month to end of 4<sup>th</sup> month using GMFM-88 scale and MAS, respectively. An alpha level of  $p < 0.05$  was the level of significance for the test. ROLLING: The value of GMFM-88 (Rolling) did not show significant improvement ( $p > 0.05$ ) at end of 2<sup>nd</sup> month as compared to 0<sup>th</sup> month. However, at 0<sup>th</sup> month to end of 4<sup>th</sup> month the scores of rolling in GMFM-88 showed significant improvement ( $p < 0.05$ ) that is  $p = 0.003$  and  $t = 3.256$  compared to both at 0<sup>th</sup> month and end of 2<sup>nd</sup> month; SITTING: The value of GMFM-88 (Sitting) did not improve significantly ( $p > 0.05$ ) at end of 2<sup>nd</sup> month as compared to 0<sup>th</sup> month. However, at end of 0<sup>th</sup> month to end of 4<sup>th</sup> month it showed significant improvement ( $p < 0.05$ ) i.e.  $p = 0.000$  and  $t = 6.329$  compared to both at 0<sup>th</sup> month and after 2<sup>nd</sup> month; CRAWLING: The value of GMFM-88 (Crawling) showed significant ( $p < 0.05$ ) improvement in GMFM scores i.e.  $p = 0.021$  and  $t = 2.452$  at end of 2<sup>nd</sup> month as compared to 0<sup>th</sup> month and also showed significant ( $p < 0.05$ ) improvement in GMFM-88 Score i.e.  $p = 0.021$  and  $t = 2.449$  compared to both at 0<sup>th</sup> month and 2<sup>nd</sup> month; STANDING: The value of GMFM-88 did not show significant ( $p < 0.05$ ) improvement in GMFM-88 score at end of 2<sup>nd</sup> month and at end of 4<sup>th</sup> month as compared to 0<sup>th</sup> month and at end of 2<sup>nd</sup> month to end of 4<sup>th</sup> month; WALKING: The value of GMFM-88 did not show significant ( $p > 0.05$ ) improvement in GMFM-88 scores i.e.  $p = 1.00$  and  $t = 0.0$  at end of 2<sup>nd</sup> month and end of 4<sup>th</sup> month as compared to 0<sup>th</sup> month and at end of and at end of 4<sup>th</sup> month. The independent t-test revealed that in children of Group A and B, gross motor function significantly improved after intervention in 3 dimensions: rolling, sitting, crawling ( $p < 0.05$ ). However, no significant improvement in standing and walking dimensions ( $p > 0.05$ ) (Figure 2).

Paired t-test was performed for intra-group comparison within each Group A and B to analyse the changes in gross motor function and muscle tone at 0<sup>th</sup> month to end of 2<sup>nd</sup> month, at the end of 2<sup>nd</sup> month to end of 4<sup>th</sup> month and 0<sup>th</sup> month to end of 4<sup>th</sup> month using GMFM-88 and MAS, respectively. An alpha level of  $p < 0.05$  was the level of significance for the test. The paired t-test for the Group A revealed significant differences in GMFM-88 scores in rolling, sitting, crawling abilities only ( $p < 0.05$ ) i.e.  $p = 0.000$  at 0<sup>th</sup> month to the end of 2<sup>nd</sup> month and end of 2<sup>nd</sup> month to the end of 4<sup>th</sup> month. However, in crawling and

walking no significant differences were observed ( $p > 0.05$ ). The paired t-test used for 0<sup>th</sup> month, at the end of 2<sup>nd</sup> month and at the end of 4<sup>th</sup> month measurements for the Group B revealed significant differences in GMFM- 88 scores in rolling, sitting, crawling and standing abilities ( $P < 0.05$ ) i.e.  $p = 0.000$  , respectively . However, only in walking ability no significant difference was observed ( $P > 0.05$ ) i.e.  $p=0.164$  and  $t= -1.468$  .The Paired-sample t-test revealed that in children of Group B, gross motor function significantly improved after intervention in 4 dimensions: rolling, sitting, crawling and standing positions. ( $p < 0.05$ ).However, in Group A gross motor function significantly improved after intervention only in the 3 dimensions: rolling, sitting and crawling position ( $p < 0.05$ ) (Figure 2).

The Independent t-test revealed that MAS scores showed significant improvements in reducing spasticity with significance  $p=0.003$  ( $p < 0.05$ ). The paired t-test revealed that mean of MAS score at 0<sup>th</sup> month, at the end of 2<sup>nd</sup> month and at the end of 4<sup>th</sup> month of Group A and Group B showed significant difference. But the mean of Group B=0.76 shows more marked decrease in spasticity than that of Group A =2.00 (Figure 3).

However, according to our results, as initially hypothesized, SIT along with conventional physiotherapy intervention had a significant positive effect on gross motor function in children with CP. Therefore from the above statistical analysis, the alternative hypothesis has been accepted and null hypothesis rejected.

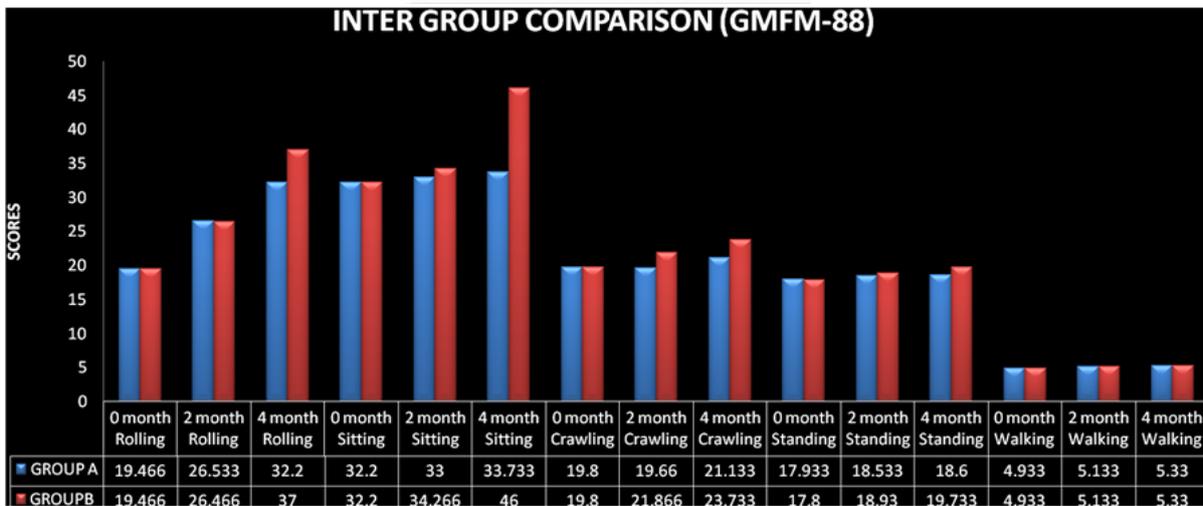


Figure 2. Inter and Intra Group comparison at 0<sup>th</sup> month, at end of 2<sup>nd</sup> month and at end of 4<sup>th</sup> month scores measurement of GMFM-88 of Group A and Group B ( X- axis showing dimensions scores, Y -axis showing Mean)



**Figure 3. Comparison at 0<sup>th</sup> month, at the end of 2<sup>nd</sup> month and at the end of 4<sup>th</sup> month of MAS measurement of Group A and Group B.**

## DISCUSSION

“Cerebral palsy describes a group of permanent disorders of the development of movement and posture, causing activity limitation i.e. attributed to non-progressive disturbances that occurred in the developing fetal or infant brain. The motor disorders of cerebral palsy are often accompanied by disturbances of sensation, perception, cognition, communication, behaviour, epilepsy and by secondary musculoskeletal problems” [8]. As a result, children with CP lack normal muscle tone and less gross motor functions which effects control of limbs, head, and overall posture [14]. The purpose of the study was to evaluate the effectiveness of sensory integration therapy on gross motor function in spastic diplegic cerebral palsy children.

The previous studies and evidences were more on effectiveness of sensory integration therapy in Autism children. Less research data was available about the effectiveness of sensory integration therapy in spastic diplegic cerebral palsy children. The present study was done to evaluate the effectiveness of sensory integration therapy on gross motor function in spastic cerebral palsy children.

30 Children were randomly divided into two groups: Group A (n=15) and Group B (n=15) with each group n=15. Group A received conventional physiotherapy and Group B received sensory integration therapy along with conventional physiotherapy. All children were

evaluated with gross motor function measurement (GMFM - 88) scale for rolling, sitting, crawling, standing and walking dimensions and for spasticity with Modified Ashworth Scale before the start of intervention and follow up was done at end of 2<sup>nd</sup> and end of 4<sup>th</sup> month with duration of 5 days per week for 4 months. The data presented in the previous chapter is discussed according to the objectives, to establish whether the children's gross motor function and spasticity improved during 4 month period. The data was examined for statistically significant information. The limitations of study were also reviewed. This study concluded that sensory integration therapy provides the spastic diplegic cerebral palsy children with graded sensory experiences. It 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. It helps in significant improvement in 3 dimensions such as rolling, sitting, crawling except in standing, walking dimensions. So, it was concluded from this study that both conventional physiotherapy and conventional physiotherapy with sensory integration therapy were effective in improving gross motor functional abilities in children. Children who had received Sensory integration therapy plus conventional physiotherapy showed more improvement in gross motor functional abilities and spasticity as compared to those who received conventional physiotherapy alone. However, statistically it was concluded that Sensory integration therapy plus conventional physiotherapy is better than alone conventional physiotherapy. The findings of the study shows that following 4 month of intervention there is a marked difference in the 0<sup>th</sup> to end of 4<sup>th</sup> month. Thus, our study supported the alternate hypothesis and rejects null hypothesis.

The present study are consistent with other studies which concluded the effect of sensory integration therapy in spastic CP. Shamsoddini, Alireza *et al.*,2010 who investigated a study to determine the comparison between the effect of Neuro- developmental treatment and sensory integration therapy on gross motor function in children with cerebral palsy. 22 children with spastic CP were randomly divided into two groups, sensory integration therapy was given to first group and Neurodevelopmental treatment was given to second group. When two groups were compared, a significant difference was found in lying and rolling ( $P=0.003$ ), sitting (0.009), crawling and kneeling (0.02) and standing ability ( $P=0.04$ ). But no significant difference in walking, running, and jumping abilities between two groups (0.417). This result showed that neurodevelopment treatment and sensory integration therapy improved gross motor function in children with cerebral palsy in four dimensions (rolling,

sitting, crawling, and kneeling, standing) [9]. This study is relevant with the present study for the use of sensory integration therapy in spastic diplegic cerebral palsy children.

Other similar studies were also found by May-Benson *et.al*, 2010 in which twenty-seven studies were systematically reviewed to identify, evaluate, and synthesize the research literature on the effectiveness of sensory integration (SI) intervention on the ability of children with difficulty processing and integrating sensory information to engage in desired occupations and to apply these findings to occupational therapy practice. Results suggest the SI approach may result in positive outcomes in Sensory-motor skills and motor planning; socialization, attention, and behavioural regulation; reading-related skills; participation in active play; and achievement of individualized goals. Gross motor skills, self-esteem, and reading gains may be sustained from 3 months to 2 years. This study results are inconsistent with the results of the present study which showed significant improvement using sensory integration therapy in spastic diplegic cerebral palsy children [7].

Vargas *et al.*, 1999 did a meta-analysis to determine whether existing studies of treatment using sensory integration approaches support the efficacy of sensory integration treatments. Sixteen studies were used to compare sensory integration therapy with no treatment and 16 studies were used to compare sensory integration therapy with alternative treatments. Results showed a significant difference between the averages sizes of effect of the earlier studies compared to more recent studies. Earlier studies showed large treatment effects favouring SI over no-treatment controls. More recent studies did not show overall positive effects. While general limitations in the methods and statistical analysis of the primary studies were summarized, there was no description of the characteristics of the individual articles [11].

So, these studies supported that there was a future need to be done to find valid results with sensory integration therapy in cerebral palsy child.

#### **LIMITATIONS OF THE STUDY:**

The number of children was very small for the study. There were only 30 children involved in present study. Small number of samples inclusion may be affected by external validity of the study and the results might not be representative of the population. Resources were limited which have a great deal of impact on the study such as literature relevant to this topic, data collection time and financial support for conducting the research project.

**FUTURE SCOPE:** Future studies can be done which focus on the use of sensory integration therapy which should last at least six months to years (6 months to 1 year) to reap any lasting benefits; it would be interesting to study the effects of the implementation of this SIT therapy and conventional physiotherapy with more children. So, Study can be done on large sample size; further study can be done with use of different outcomes measures; a further study could be done with good combination of the assessment and treatment.

### **ABBREVIATIONS**

MAS: Modified Ashworth scale, GMFM: Gross Motor Function Measure, CP: Cerebral Palsy, SID: Sensory Integration Dysfunction.

### **CONSENT**

All authors declare that 'written informed consent was obtained from the parents of children before starting the study for publication of this study report'.

### **ETHICAL APPROVAL**

This study was approved by Research and Ethical committee of University College of physiotherapy, BFUHS University, Faridkot, Punjab.

### **ACKNOWLEDGEMENTS**

Many thanks, to all children and their parents who participated in this study for their cooperation.

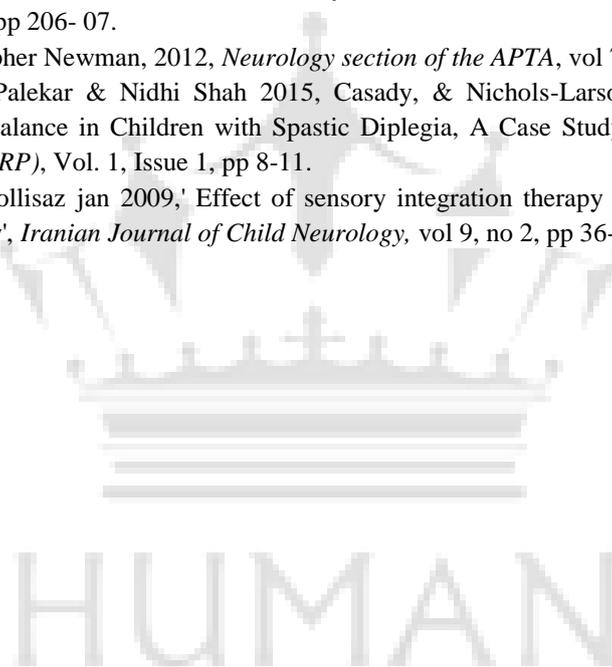
### **COMPETING INTERESTS**

Authors have declared that no competing interests exist.

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