INDIAN JOURNAL OF SCIENCE AND TECHNOLOGY

RESEARCH ARTICLE

A Case Study on the Fundamentals of Sensory Problems in Cerebral Palsy

Shikha Singh[1]*, Uzma Khan[2], Gaurav Pratap Tyagi[2]

1 Associate Professor, Maharishi Markandeshwar Institute of Physiotherapy and Rehabilitation, Maharishi Markandeshwar (Deemed to be University), Mullana -Ambala, Haryana, India
2 Assistant Professor, Faculty of Physiotherapy and Allied Health Sciences, Jyotirao Phule Subharti College of Physiotherapy, Swami Vivekanand Subharti University, Meerut, Uttar Pradesh, India

OPEN ACCESS

Received: 09-11-2023
Accepted: 23-04-2024
Published: 03-06-2024

Citation: Singh S, Khan U, Tyagi GP (2024) A Case Study on the Fundamentals of Sensory Problems in Cerebral Palsy. Indian Journal of Science and Technology 17(23): 2406-2411. https://doi.org/10.17485/IJST/v17i23.2832

* **Corresponding author**.

shikhasinghmpt@gmail.com

Funding: None

Competing Interests: None

Published By Indian Society for Education and Environment (iSee)

ISSN
Print: 0974-6846
Electronic: 0974-5645

Abstract

Objective: To find out the sensory problem apart from the motor issues in a case of Cerebral Palsy (CP) with a complicated birth history. **Method:** Along with a thorough motor assessment of the child, the parents of CP Child were subjected to an interview for the examination of associated sensory problems. The caregiver's experiences related to sensory problems were recorded and divided into different domains. For the evaluation of complications and motor symptoms, a variety of assessment techniques were used. **Findings:** Sensory issues find out under ten domains: Gustatory, Tactile, Vestibular, Proprioception, Movement Processing, Visual, Auditory, Olfactory, General Processing, and Stereognosis. Motor development was delayed and hampered in the child. Spasticity was significantly marked in the lower limbs because its gait and balance were disturbed. Along with the motor problems sensory issues are significantly disturbed in the presented case. **Novelty:** This study is unique not only because it addressed an exceptional case of CP with a complex birth history. In addition, the study concentrated on the sensory issues that were neglected in earlier research. **Conclusion:** The child of CP exhibited many sensory problems along with motor complications. Before starting treatment it is important to evaluate the sensory issue, apart from motor symptoms.

Keywords: CP (Cerebral Palsy); MAS (Modified Ashworth Scale); GMFCS (Gross Motor Function Classification System); PROM (Passive ROM Exercise); TUG (Timed Up and Go)

1 Introduction

The neurological condition of Cerebral Palsy (CP) is characterized by abnormal tone, posture, and movement. Major indicators of risk for CP include preterm delivery and low birth weight[(1)]. The central nervous system lesion in CP is non-progressive, although the multisystem effects may eventually reduce overall function.

It is crucial to plan goals for therapy and create an interdisciplinary approach to handle numerous secondary conditions, taking into account multisystem compensations and repercussions that happen in children with CP[2]. Feeding difficulties are caused by both sensory processing issues and visual impairment, which additionally affects the nutritional status of CP children[3]. Children with CP exhibit quite distinct changes in how they react to everyday sensory stimuli. CP children having greater GMFCS levels showed sensory issues relating to posture. The creation of screening tools is required to find sensory problems in children with CP whose motor functioning is affected by sensory difficulties. A deeper comprehension of a child's functioning may enable specific strategies to encourage environmental adjustments, motor development, and engagement in daily life[4]. Sensory function in CP children is generally impacted by lesion timing, location, extent, ascending sensory tract integrity, and anatomical abnormalities of the somatosensory areas[5]. Multimodal information processing is impaired in many pediatric neurological diseases associated with abnormal psychomotor development. Due to their motor impairment and/or initial damage to some sensory pathways, children with CP frequently find it difficult to accurately interpret sensory signals[6]. In earlier research, the main emphasis was on how different treatment strategies affected a specific symptom or only the relationship between two types of symptoms was noted[7]. The purpose of this study was to identify all sensory issues present in a child with CP.

Novelty: The novelty of the study lies in the rare case of CP with complicated birth history. Most of the earlier studies were done for the examination of CP children with a focus only on motor examination. This study was conducted to find out unusual sensory problems which were overlooked in previous research.

2 Methodology

- **Study Design:** A single case study design.
- **Study Location:** Physiotherapy OPD of Jyotirao Phule Subharti College of Physiotherapy.
- **The case:** This case report details problems experienced by a 3-year-old boy who has spastic diplegia with an athetoid component. The child has shown functional delays in sitting, reaching, and walking, as well as limitations in his ability to move his limbs and trunk. The child's parents gave their written consent. The overall focus of the study was explained to parents as part of the informed consent process.
- **Birth History :** Mother aged 27-year primigravida with Triplet and Rh negative pregnancy. At 33 weeks, LSCS was performed under general anesthesia. She gave birth to three babies: a boy weighing 1.3 kg with vertex presentation, a second baby boy weighing 1.6 kilograms in the breech position, and a female weighing 1.8 kilograms in the breech position. After delivery, all three babies were watched in the NICU. One of them (Case) was diagnosed with a low (i.e. six) Apgar score.
- **Developmental History:** The child could hold his neck and sit with assistance, but he was unable to stand or walk unassisted at this time. He was a monosyllabic speaker and attentive to sound. He was unable to make eye contact. He can recognize gender and had a general civil sense.

3 Results and Discussion

I. Result

Motor examination: The child's independent mobility was severely restricted (Table 1). His lower limbs revealed spasticity and stiffness and had a limited active range of motion, despite having a full passive range of motion in both his arms and legs. Additionally, he had trouble starting and concentrating on specific movements. He was unable to crawl, but he was able to go forward with the use of the walker. With some support, he can turn, steer, and stay upright. His level II in the Gross Motor Function Classification System reflects his capacity to sit and his requirement for mobility aids. At age 3, he scored 66.37% on the Gross Motor Function Measure-66, which was below normal for his age. The parents of the child reported no significant cognitive or linguistic impairments.

Table 1. Motor Examination of Child

Motor Examination					
Examination	**Test**	**Action**	**Result**		**Interpretation**
			Right	**Left**	
		Triceps	$\frac{1}{4}$	$\frac{1}{4}$	Slight increase
		Biceps	0/4	$\frac{1}{4}$	Normal/Slight increase
Muscle Tone	MAS	Quadriceps	02-Apr	02-Apr	Marked increase

Continued on next page

Table 1 continued

		Hamstring	$\frac{1}{4}$	$\frac{1}{4}$	Slight increase
		Gastrocnemius	$\frac{3}{4}$	$\frac{3}{4}$	Considerable Increase
Range of motion: PROM		Hipext (knee flexed)	9°	5°	Decreased ROM
(All extremities were in the	Goniometry	Knee extension	-7°	-10°	Decreased ROM
normal limits except the		Dorsiflexion	12°	5°	Decreased ROM
following)		SLR	80°	75°	Decreased ROM
Gross Motor Function	(GMFCS)	Walking in most settings, stair climbing	GMFCS Level II		Difficulty in walking long distances without assistance
					Climb stairs holding onto a railing

PROM (Passive ROM Exercise), MAS (Modified Ashworth Scale), GMFCS (Gross Motor Function Classification System)

Table 2. Activity Examination of Child

Activity	Test	Action	Results	Interpretation
Mobility	Functional Mobility Scale	5 meters	2/6	Walker used
		50 meters	1 /6	Walker used
		500 meters	N (does not apply)	Unable to ambulate distance
Gait	10 Meter Fast Walk Test	Reverse walker (modInd)	2trialaverage: 1.03m/s	Dependent ambulation
	Clinical observation Of gait mechanics	Base of support and Joint posture	Crosse leg, Narrow base of support; equino valgus	Scissor gait
Balance	TUG	Standing and walking	21.4 seconds	Difficulty in walking long distances without a gait aid
	TCMS	Selective movements in sitting	Total score: 31/57	Dynamic sitting balance/selective movement control: 11/27 Static sitting balance: 13/20 Dynamic reaching: 7/10
	PBS	Standing in different positions	Total score: 40/56	The patient found it difficult to: Stand on one foot, Stand in tandem, and Place alternate feet on the stool. turning around and looking back
Motor Function	Gross Motor Function Mobility 66	Rolling, Lying	12/12points	100%
		Sitting	40/45points	88.88%
		Kneeling Crawling	27/30points	90.00%
		Standing	14/39points	35.89%
		Walking	13/72points	18.05%
Motor Developmental	PDMS-2	subscales:	raw scores:	age equivalence; percentile rank
		Stationary	37/60points	18months;16thpercentile Rank
		Locomotion	70/178points	13months;<1percentile Rank
Disability	Pediatric Evaluation of Disability Index	Functional mobility domain	38/65points	59.90%

TUG (Timed Up and Go), TCMS (The Trunk Control Measurement Scale), PBS (Paediatric Balance Scale) PDMS-2(Peabody Developmental Motor Scale)

Sensory examination:

The investigator contacted to parents of CP children in the Physiotherapy OPD of Subharti College of Physiotherapy for a direct interview, and data was collected. Parents were asked to bring in the items that are important to evaluate the sensory difficulties. First, parents were asked to list several issues that they were aware of in their children. Further, Encouraging parents to answer the most amounts of items that they believe are right based on their experience. After that, the parents were given a pool of items which was collected from the literature, and they were asked to add the additional number of items that were not included in the literature. For related sensory problems, a total of 10 domains (Gustatory, Tactile, Vestibular[8], Proprioception, Movement Processing[1], Visual, Auditory[9], Olfactory[10], General Processing[11], Stereognosis[12], were created. Some of them were Negative Signs (Table 3) others are Abnormal Positive Signs (Table 4).

Table 3. Signs of under responsiveness

Negative Signs	
GUSTATORY	
The child did not react to the temperature of the food given to him/her.	The child did not tolerate tooth brushing.
TACTILE	
The child is unable to differentiate between soft and hard touch.	The child does not allow cleaning with a towel /cloth.
The child does not react to wiping off the face.	The child does not react while going to in public places (no fear of physical contact).
The child does not show favorites for certain textures of clothes.	The child does not react to trimming of the nails.
The child does not react to being hugged.	The child is not able to notice hurdles on the way.
The child does not react to strangers.	The child does not react to touch.
VESTIBULAR	
The child does not react to moving activities (e.g., in games or swing).	
PROPRIOCEPTION	
Child unable to bear deep pressure (e.g., deep pressure massage and tight hug).	The child was not enjoyed playing activities in which he/she has to hang.
The child does not enjoy playing with moving objects.	
MOVEMENT PROCESSING	
The child does not react to bouncing activities (does not enjoy the trampoline).	
VISUAL	
The child did not give attention to visual stimuli (e.g., blinking of a light bulb).	The child did not enjoy looking at bright objects.
The child is not able to judge the direction.	The child did not seem keen on the bright-colored objects.
The child did not pay attention to moving objects.	The child did not respond in front of the mirror.
AUDITORY	
The child did not pay attention to the noise.	The child did not react to unfamiliar sounds on the road.
The child did not pay attention during calling him/her.	
OLFACTORY	
Child not able to differentiate smell (pleasant or unpleasant).	
GENERAL PROCESSING	
The child did not follow the set routine for sleeping.	The child did not make eye contact (whenever require).
STEREOGNOSIS	
The child is not able to judge the shape of an object (a child of the same age).	

Table 4. Signs of over responsiveness

(Abnormal Positive Signs)	
GUSTATORY	
Usually, saliva expelled from the mouth of the child.	The child wants to eat only specific textures of food.
TACTILE	
The child becomes irritated when anyone suddenly touches him (not tolerate touch).	Child use to cause injury to himself/herself (pinch, bite, hit, or scratch).
VESTIBULAR	
The child feels fear while traveling (e.g., cries badly while traveling in a car, bus, or train).	
VISUAL	
Child squints to improve visual input. The child feels more comfortable in darkness or dim lighting. The child is usually having double vision.	The child looks markedly toward the object and person. Children frequently stair off into space. The child feels difficulty in tracking moving objects.
AUDITORY	
The child is distorted by loud sounds (seems fearful).	Child stop playing with the loud noise.
GENERAL PROCESSING	
The child is irritated when his or her daily routine is disturbed (reacts very oddly). The child takes more time to respond to a question (than other children of the same age). The child feels uneasy in new situations.	The child leaves situations (e.g. noise, unfamiliar). Child awakes from sleep easily (sometimes without any cause).
OLFACTORY	
Child smells a toy before playing with them.	

II. Discussion

Children with CP frequently experience sensory and motor deficiencies, which may adversely affect their everyday lives and functional activities.[13] Food fussiness has been related to increased sensory sensitivity in both normal and CP child. Sensory issues and dietary fussiness are described as important issues for concern in children with neurological disorders[14]. During a time of rapid neurodevelopment and activity, perinatal dystonia, also known as dystonia cerebral palsy, begins to develop[15]. Activity-based neurorehabilitation treatment can enhance voluntary sensory-motor function when non-invasive spinal neuromodulation is used as an intervention The majority of the earlier studies for connecting the treatment were done for motor problems. However, thorough sensory examination has been neglected in earlier studies[16].

Numerous multisystem effects of a CP child need to be addressed, and they are best controlled by accepted standards. Before starting the therapies, it is crucial to decide on the treatments' objectives and advantages. It is important to thoroughly weigh the advantages and disadvantages of every given intervention. For that, a comprehensive assessment must be done. Children with CP get therapy with the purpose of reducing discomfort, preventing or lessening contractures, improving ambulation, facilitating activities of daily living (ADL), encouraging involvement in rehabilitation, and enhancing ease of care and safety[17].

According to various research, the prevalence of visual impairment in CP children ranges from 40 to 50% of kids. In CP, visual impairment is frequently caused by the same brain injury that results in movement issues[18]. Up to 39% of CP patients experience hearing loss. Each of the ten domains resulted from a white matter injury, and they are all connected to one another, as well as with motor symptoms. Sensory evaluation should be combined with the assessment of the patient's motor examination to provide a complete treatment rather than one that only addresses their motor concerns[19]. It is believed that damage to the growing brain is what causes the neurodevelopmental disorder known as CP, which is marked by abnormalities of muscle tone, movement, and motor abilities. CP also deals with a number of sensory difficulties in addition to motor disorders.

4 Conclusion

Children with CP should receive treatment to manage various co-morbid conditions such as epilepsy, cognitive impairment, vision, hearing loss and problem in gastrointestinal function. They exhibit a wide range of sensory abnormalities in addition to associated complications falling under the 10 sensory domains. Gustatory, Tactile, Vestibular, Proprioception, Movement Processing, Visual, Auditory, Olfactory, General Processing, Stereo gnosis. Sensory symptoms exhibit abnormally positive or negative characteristics. Previous studies were mainly focused on motor issues and the associated sensory issues were often

being over looked. Given that CP children have significant sensory problems, this study suggests that CP patients must have a full evaluation that should include a thorough sensory assessment in addition to motor examination.

References

1) Patel DR, Neelakantan M, Pandher K, Merrick J. Cerebral palsy in children: a clinical overview. *Translational Pediatrics*. 2020;9(Suppl 1):S125–S135. Available from: https://dx.doi.org/10.21037/tp.2020.01.01.
2) Wahyuni LK. Multisystem compensations and consequences in spastic quadriplegic cerebral palsy children. *Frontiers in Neurology*. 2022;13:1–13. Available from: https://doi.org/10.3389/fneur.2022.1076316.
3) Cemali M, Cemali Ö, Günal A, Pekçetin S. Relationship between Sensory Processing Skills and Feeding Behaviors in Children Aged 3–6 Years with Cerebral Palsy with Cerebral Visual Impairment. *Children*. 2023;10(7):1–11. Available from: https://dx.doi.org/10.3390/children10071188.
4) Ericson A, Åsa Bartonek, Tedroff K, Lidbeck C. Responses to Sensory Events in Daily Life in Children with Cerebral Palsy from a Parent Reported Perspective and in a Swedish Context. *Children*. 2023;10(7):1–13. Available from: https://dx.doi.org/10.3390/children10071139.
5) Knijnenburg ACS, Steinbusch CVM, Janssen-Potten YJM, Defesche A, Vermeulen RJ. Neuro-imaging characteristics of sensory impairment in cerebral palsy; a systematic review. *Frontiers in Rehabilitation Sciences*. 2023;4:1–13. Available from: https://doi.org/10.3389/fresc.2023.1084746.
6) Giannoni P. Sensory-Motor and Perceptual Problems in Cerebral Palsy. In: Cerebral Palsy . Springer, Cham. 2022;p. 237–262. Available from: https://doi.org/10.1007/978-3-030-85619-9_6.
7) Falisse A, Pitto L, Kainz H, Hoang H, Wesseling M, Van Rossom S, et al. Physics-Based Simulations to Predict the Differential Effects of Motor Control and Musculoskeletal Deficits on Gait Dysfunction in Cerebral Palsy: A Retrospective Case Study. *Frontiers in Human Neuroscience*. 2020;14:1–17. Available from: https://dx.doi.org/10.3389/fnhum.2020.00040.
8) Barakat MKA, Elmeniawy GH, Abdelazeim FH. Sensory systems processing in children with spastic cerebral palsy: a pilot study. *Bulletin of Faculty of Physical Therapy*. 2021;26(1):1–10. Available from: https://dx.doi.org/10.1186/s43161-021-00044-w.
9) Warutkar VB, Kovela RK. Review of Sensory Integration Therapy for Children With Cerebral Palsy. *Cureus*. 2022;14(10). Available from: https://dx.doi.org/10.7759/cureus.30714.
10) Nakashima T, Katayama N, Sugiura S, Teranishi M, Suzuki H, Hirabayashi M, et al. Olfactory Function in Persons with Cerebral Palsy. *Journal of Policy and Practice in Intellectual Disabilities*. 2019;16(3):217–222. Available from: https://dx.doi.org/10.1111/jppi.12284.
11) Brun C, Élodie Traverse, Élyse Granger, Mercier C. Somatosensory deficits and neural correlates in cerebral palsy: a scoping review. *Developmental Medicine & Child Neurology*. 2021;63(12):1382–1393. Available from: https://dx.doi.org/10.1111/dmcn.14963.
12) White H, Eastman J, Augsburger S, Riley S, Iwinski H. A case series assessing relationship between active motions and stereognosis in cerebral palsy. *Journal of Clinical Images and Medical Case Reports*. 2022;3(10):1–4. Available from: https://dx.doi.org/10.52768/2766-7820/2105.
13) Batool S, Saeed A, Ghous M, Khushnood K. Augmented effects of sensory integration therapy and virtual reality on movement and balance issues in cerebral palsy: a pilot study. *The Rehabilitation Journal*. 2022;6(4):451–456. Available from: https://doi.org/10.52567/trj.v6i04.165.
14) Smith B, Rogers SL, Blissett J, Ludlow AK. The relationship between sensory sensitivity, food fussiness and food preferences in children with neurodevelopmental disorders. *Appetite*. 2020;150. Available from: https://dx.doi.org/10.1016/j.appet.2020.104643.
15) McClelland VM, Lin JP. Sensorimotor Integration in Childhood Dystonia and Dystonic Cerebral Palsy—A Developmental Perspective. *Frontiers in Neurology*. 2021;12:1–14. Available from: https://dx.doi.org/10.3389/fneur.2021.668081.
16) Lyons-Warren AM, Guez-Barber D, Thomas SP, Tantry EK, Mahat A, Aravamuthan BR. Sensory symptoms across the lifespan in people with cerebral palsy. Cold Spring Harbor Laboratory. 2023. Available from: https://doi.org/10.1101/2023.07.21.23292955.
17) Hastings S, Zhong H, Feinstein R, Zelczer G, Mitrovich C, Gad P, et al. A pilot study combining noninvasive spinal neuromodulation and activity-based neurorehabilitation therapy in children with cerebral palsy. *Nature Communications*. 2022;13(1):1–7. Available from: https://dx.doi.org/10.1038/s41467-022-33208-w.
18) Duke RE, Chimaeze T, Kim MJ, Ameh S, Burton K, Bowman R. The Effect of Insight Questions Inventory and Visual Support Strategies on Carer-Reported Quality of Life for Children With Cerebral Palsy and Perceptual Visual Dysfunction in Nigeria: A Randomized Controlled Trial. *Frontiers in Human Neuroscience*. 2021;15:1–11. Available from: https://dx.doi.org/10.3389/fnhum.2021.706550.
19) Trott K, Powell A, Inverso Y, Parkes WJ. Auditory Rehabilitation in Children with Cerebral Palsy. *Cerebral Palsy*. 2020;p. 811–818. Available from: https://doi.org/10.1007/978-3-319-74558-9_64.