Effectiveness of Sensory Integration Therapy for Language Development in Children with Cochlear Implant: A Pilot Study

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Abstract

Background: Sensory processing disorder (SPD) is known to occur in diverse populations, including children with hearing loss and cochlear implants (CI). However, it is still unclear, and no systematic investigation was done to find out whether SPD is associated with hearing impairment and CI.

Objectives: Therefore, the aim of the study was to find the prevalence of SPD in children with CI and evaluate the efficacy of sensory integration therapy for developing language in children with CI.

Study Design: Cross sectional survey and quasi-experimental pre-post design

Methods: A cross-sectional survey and quasi-experimental pre- post-test design were adopted for the study and consisted of 2 phases. In phase 1, 100 children with CI were surveyed to find out the prevalence of SPD. In phase 2 of the study effectiveness of sensory integration therapy on language development was investigated on 40 children with CI having SPD. The baseline and post-test measurement was done using an integrated scale of development. The control group underwent conventional OT and speech therapy and experimental group underwent SIT and speech therapy for a total of 50 sessions, 45 min per session, for 10 weeks.

Results: The findings revealed atypical performance in 29% of children, of which 19% showed probable difference and 13% showed definite difference on the short sensory profile. In phase 2, the experimental group showed a significant difference in expressive language and in receptive language ($P < 0.05$).

Conclusion: The study concluded that children with CI have sensory processing problems. Sensory integration therapy is not only effective in language development but also in other developmental components, in children with CI.

Key Words: Cochlear Implant, Hearing Impairment, Sensory Integration Therapy, Expressive, Receptive Language

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Period of Study
From 2nd October, 2014 to 21st March, 2016

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INTRODUCTION

In India, 63 million people (6.3%) suffer from significant hearing loss. The National Sample Survey, 58th round (2002) surveyed disability in Indian households and found that hearing disability was the 2nd most common cause of disability and topmost cause of sensory deficit. According to the WHO global estimates, the prevalence of hearing loss in adult is 91% and children is 9%, out of which 56% of male and 44% of females are affected with hearing loss.[1]

Children with profound sensorineural hearing loss (SNHL) are at significant risk for serious speech and language delays that can impact their communication, academic, and social development, economic and educational backwardness, social isolation, and stigmatization. However, hearing impaired children have also a higher risk for motor and more specifically vestibular problem.[2,3] When the cochlea suffers damage, so does the vestibular system because it works together with the cochlea to process sensations of sound and movement.[2] The vestibular system affects auditory-language processing and is in some way dependent on subcortical sensory integration. One of the treatments for profound hearing loss is the cochlear implant (CI) that allows people with the severe SNHL to perceive sound. CI's have become an option at a younger age for profound hearing loss. The process of inserting electrode into cochlea can impair vestibular receptor integrity.[4]

Rhoades and Chisolm[5] reported that 78% of the children with hearing loss had sensory processing difficulties. The data also showed that atypical behaviors were present in all domains but were most prevalent in auditory and vestibular processing, followed by oral and tactile processing, and least prevalent in visual processing.

To date, there has been no systematic investigation examining whether sensory processing disorder (SPD) is present in people with hearing impairment, who are fitted with unilateral or bilateral CI device. Even though studies have been done earlier, they used a very small sample size (30 children –from North Texas). Studies exploring sensory integration therapy as an intervention for children with CI have not been investigated much.

However, emerging research suggests that sensory integrative challenges - in particular, differences in vestibular functions - may be common in children who receive CIs.[6,7] Therefore, exploration of

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sensory integrative pattern including skills related to vestibular function and in children with CI is warranted.

Thus, the researcher wanted to investigate the prevalence of sensory processing disorder in children with CI. Second, to find out the effectiveness of sensory integration therapy for developing language in children with CI.

METHODS

Research Design

A cross-sectional survey and quasi-experimental pre post-test design were adopted for the study. The study consisted of 2 phases, in Phase 1 a survey was done to find out the prevalence of SPD among children with CI. Phase 2 included study of the effectiveness of sensory integration therapy on language development using a control group design.

Ethical Consideration

Approval to conduct the study was obtained from the Institutional Review Board. Second, a formal consent was obtained from the authorities' of the ENT hospital, Hearing aid center and parents of the children who participated in the research study as per the declaration of the Helsinki guidelines.

Phase 1 - Survey Study

Study participants were 100 children with hearing deficit and delay in language development, with CI. Both boys (57) and girls (43) between 3 and 10 years with a mean age of 5.28 ± 1.68 years were included in the study. Children who had complications after surgery suspected to have autism spectrum disorders, blindness, and other developmental disorders were excluded from the study. Sample size was estimated based on evidence from previous studies.[5,6] Convenient sampling method was used to select the sample based on criteria.

Tools used

Short sensory profile

Short sensory profile was used to measure the responses of children to sensory events in their daily life. It is a screening tool which identifies if a child has sensory processing issues.[7]

Procedure

The occupational therapist completed the short sensory profile questionnaire along with the parent as most of them were illiterate. The collected data were then subjected to statistical analysis.

Phase 2 - Effectiveness of SIT on Language Development in Children with CI

Study participants were 40 children with hearing deficit, delay in language development, who had undergone CI and having sensory processing disorder (SPD) of probable (29-27) and definite difference on the Short sensory profile.

The participants were randomly allotted to experimental (n = 20) and control group (n = 20). The experimental group included children between 3 and 10 years of age, with a mean age of 4.57 ± 1.47 years and a CI mean age of 3.72 ± 1.35 years, of whom 11 were boys and 9 were girls.

The control group consisted of 20 children with CI of whom were 16 boys and 4 girls, with a mean age of 5.52 ± 1.28 and a CI mean age of 3.63 ± 1.26 years children who had complications after surgery, suspected to have autism spectrum disorders, blindness, and other developmental disorders were excluded from the study. Sample size was estimated based on evidence from the previous studies.[6,7]

Tools, equipments, and outcome measures

Integrated scale of development measures domains of listening, receptive and expressive language, speech, cognition, and social communication according to the age of the child. Raw scores based on age were added to give the final score for a component.[8]

Procedure

Need and purpose of the study were explained to the parents of the children, and informed consent was obtained to ensure confidentiality. The pre-test and post-test were done using integrated scales of development for both control and experimental group.

Intervention for control group

The 20 children in control group underwent regular speech therapy[9] and conventional occupational therapy for 45 min, 5 days a week, for a period of 10 weeks. The conventional OT included basic cognitive perceptual, gross and fine motor skills and self-care training. After completion of the therapy session, the caregiver was briefed about the session. They were informed about both positive and negative behaviors that the child showed during the session. The parents were given a list of activities as home program.

Intervention for experimental group

The 20 children in experimental group underwent sensory integration therapy and speech therapy for 45 min/day, 5 days a week for 10 weeks.

The treatment protocol was individualized as per the child's capabilities and disorders based on the short sensory profile. Each session of therapy followed fidelity guidelines (this means that each session uses a standardized method of delivering Ayres sensory integration).[10] Opportunity for sensory experiences of vestibular (fast/slow and sudden changes in movement on different types of swing, therapy ball, proprioceptive, and tactile activities of the just right challenge were given to children). After completion of the therapy session, the caregiver was briefed about the session. They were informed about both positive and negative behaviors that the child showed during the session. A list of activities to be done at home to meet the child's sensory needs was given to the parents. Parents were taught to monitor child's alertness level and strategies for self-regulation.

Data Analysis

The scores of experimental and control group were subjected to statistical analysis using IBM® SPSS software Version 20. Descriptive statistics were used to find out the mean, SD, and percentage of prevalence. Mean difference was calculated by subtracting the post-test mean values from the pre-test mean values to find out the effectiveness of therapy. Effect size was calculated by dividing the mean change in score by the SD of baseline scores in children who had received an intervention and were expected to change. Effect size was interpreted according to criteria set by Cohen's d. An effect size of 0.2–0.49 was interpreted as small, 0.50–0.79 as moderate and 0.80 or greater as large.

Non parametric test: Wilcoxon signed rank test was used for the within-group comparison. Mann–Whitney *U*-test was used for the comparison between groups. $P < 0.05$ was taken as statistical significance.

RESULTS

Phase 1: The findings of Phase 1 of the study revealed the presence of SPD in 29% of children with CI. Among these 19% showed probable difference and 13% showed the definite difference on the short sensory profile. Graph 1a the data in the present study also showed that atypical behaviors were present in all domains but were most prevalent in auditory filtering (45%), tactile sensitivity (29%) and movement sensitivity (25%) followed by under-responsive and seek sensation (21%) and least prevalent in low energy (8%), taste and smell (8%), and visual and auditory(8%) Graph 1b.

Phase 2: The result of Phase 2 showed that there was no significant difference in the pre-test scores of the integrated scale of development between the groups except in audition and receptive components this could be because both the groups were already undergoing speech therapy before intervention. On post-test when compared between the groups the pragmatics component was found to be significant ($U = 47$, $P < 0.05$) which indicates that SIT helped the experimental group to improve in social communication skills. But on comparing the mean values of speech were 19.3 and 21.88 and in expressive language 19.45 and 21.55 in the control and experimental group, respectively. This shows that the experimental group improved in speech and expressive language following SIT, and speech therapy Table 1.

Further, in the control group, there was a significant difference from pre-test to post-test in all components of the integrated scale of development, except in pragmatics. The mean difference shows that there was more improvement in the expressive language (6.25) component this shows that the speech therapy sessions helped in improving these components though there was not much improvement in the social communication component (0.75) as they had not undergone SIT Table 2.

Whereas the experimental group showed a significant difference ($P \leq 0.05$) in all the components of the integrated scale of development from pre-intervention to post-intervention which proves that SIT along with auditory and speech therapy brought about a change in all areas of development Table 3.

There was a moderate effect size in audition (0.6), cognition and pragmatics and large effect size in receptive language, expressive language and speech for the experimental group. Whereas control group showed small effect size in audition and cognition, moderate effect size in receptive language, expressive language, speech, and pragmatic Table 2.

DISCUSSION

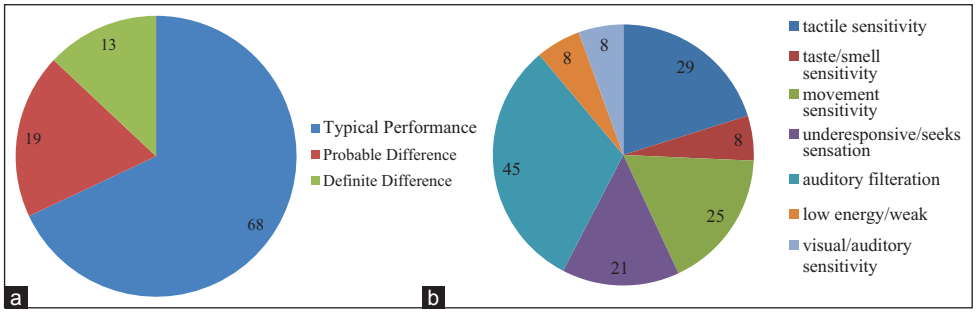
Prevalence of SPD in Children with CI

This study sought to investigate whether SPD is prevalent in children with CI. The findings of our study revealed the presence of SPD in 29% of children with CI. Among these 19% showed probable difference and 13% showed definite difference on the short sensory profile. These findings are in contrast with the study of Bharadwaj *et al*. wherein they found that 70% of children had some sort of SPD on the short sensory profile, this could be because the data were taken from a single center.[5]

The data in the present study also showed that atypical behaviors were present in all domains but were most prevalent in auditory filtering (45%), tactile sensitivity (29%) and movement sensitivity (25%) followed by under-responsive and seek sensation (21%) and least prevalent in low energy (8%), taste and smell (8%), and visual and auditory (8%). These findings are consistent with the study of Koester *et al*.[7]

Previous studies have shown that children with hearing loss may also experience vestibular dysfunction.[2] The results of

Graph 1: (a) Percentage Prevalence of Sensory Processing Disorder in Children with Cochlear Implants on the Short Sensory Profile. (b) Percentage of Distribution of Children in Each Domain of Short Sensory Profile



present study are also consistent with these findings wherein out of 100 children with CI who were tested with SSP, 25 children showed a dysfunction in movement sensitivity. This finding tends to reflect hyperresponsiveness to vestibular sensation because children with CI seem to show signs of poor vestibular processing versus heightened reactivity to movement, the questions on the SSP are not likely to capture the type of vestibular dysfunction children with CI experience. Selz and colleagues suggested that etiological factors responsible for hearing loss may also affect the vestibular system, given the proximity of the cochlea, to the vestibular end organ.[11]

The fact that the large subset of children was classified as having probable and definite difference in the domain of tactile sensitivity is supported by Jean Ayres statement that the vestibular, proprioceptive, and tactile system are highlighted as the precursors to the development of the auditory and visual system. Further, it was noted that small subset of children actually showed the least involvement of taste/smell, low energy/weak, and visual/auditory processing. This might suggest that people with hearing impairment have to monitor the environment by enhanced recruitment of multimodal areas of the cortex.

Effectiveness of Sensory Integration therapy on Speech and language in children with CI

On investigating the effect of SIT at baseline there was no significant difference on the pre-test scores of the integrated scale of development between the groups, except in audition and receptive components, therefore, both the components were not comparable. However, on post-test, it was found that the experimental group had a higher mean value in the above 2 components than the control group, thereby indicating that SI therapy played a role in improving the audition and receptive skills post-intervention.

In this study, there was an improvement in the pragmatics component (in social communication skills) in the experimental rather than in the control group (U=47, $P < 0.05$). These findings are consistent with the study conducted by Megha, Pooja, wherein they found that sensory integration therapy had an effect on social and self-care skills in children with Autism.[12] But on comparing the mean values the experimental group, improved more in the areas of speech (x = 21.88) and expressive language (x = 21.55) following SIT, auditory and speech therapy Table 1.[9,10]

Post-intervention the control group had improved in all components of the integrated scale of development, except in pragmatics. The mean difference shows that the control group improved in the expressive language component indicating that the auditory and speech therapy sessions helped in improving these components.[9] However, there was not much improvement in the social communication component as they had not undergone SIT. SIT postulates that on controlled sensory input the children show adaptive responses. In the current study social communication improved since as part of therapy the children had to maintain eye contact, interact with the therapist, demonstrate smile response, and turn taking during SIT sessions.

In the experimental group (Table 2) highest change was noted in the receptive language followed by expressive language and speech. The least change was noted in the audition component. This could

Table 1: Comparison of All Components of Integrated Scale of Development between the Groups on Pre- and Post-Test

Test	Outcome measure	Group	N	Mean	U score	Significant (two-tailed)
Pre-test	Audition	Control	20	24.85	113.000	0.017*
		Experimental	20	16.15		
	Receptive	Control	20	24.35	123.000	0.036*
		Experimental	20	16.65		
	Expressive	Control	20	23.55	139.000	0.096
		Experimental	20	17.45		
	Speech	Control	20	23.48	140.500	0.102
		Experimental	20	17.53		
	Cognition	Control	20	20.05	149.000	0.165
		Experimental	20	17.95		
	Pragmatics	Control	20	17.35	137.000	0.084
		Experimental	20	23.65		
Post-test	Audition (listening)	Control	20	22.08	168.500	0.389
		Experimental	20	18.93		
	Receptive language	Control	20	20.60	198.000	0.956
		Experimental	20	20.40		
	Expressive language	Control	20	19.45	179.000	0.565
		Experimental	20	21.55		
	Speech	Control	20	19.13	172.500	0.455
		Experimental	20	21.88		
	Cognition	Control	20	20.08	191.500	0.818
		Experimental	20	20.93		
	Pragmatics (social communication)	Control	20	12.85	47.000	0.000***
		Experimental	20	28.15		

*Significance at less than 0.05, ***Significance at less than 0.001

be because the children in this group showed more problem in the auditory filtering and thereby did not develop much of listening skills (auditory awareness, listen accurately, response to sound by smile or head turning, and listening to own voice). The findings of the present study are consistent with the findings of the study conducted by Jean Ayres and Zoe Mailloux, that there was a rate of language growth before and after starting occupational therapy.[13] The children demonstrated notable gains on expressive language measures. Their findings also suggest a definite relationship between expressive language development and vestibular processing which takes place during sensory integrative therapy.[14] Similarly, in this study, the control group children showed the highest gain in expressive language. Michael *et al*.[15] found an increase in spontaneous verbal language use for mentally deficient and five developmentally retarded preschoolers immediately after the vestibular stimulation periods, and suggest vestibular stimulation as an effective nonverbal intervention method for the facilitation of spontaneous language. Therefore, this suggests that sensory integration has an effect on language development.

Scott *et al*. in their study on sensory pattern contribution to developmental performance in children with the autism spectrum disorder have suggested that sensory processing patterns are strongly related to preschool-age children receptive and expressive language abilities[16] specifically, we found that children with high scores in low energy/weak and auditory/visual sensitivity showed an increase in receptive and expressive language skills conversely, children who showed more difference in hyporesponsivity and taste/smell sensitivity demonstrated a decrease in language skills. Interestingly, sensory seeking/distractibility significantly contributed to receptive, not expressive language skills.

Both the groups also showed an improvement in the cognitive domain, i.e., in areas of awareness, looking at objects, imitation of action, and symbolic play and basic concepts had improved.

In this study, the mean difference of the experimental group, the percentage of improvement and the significant difference in the post-test scores of the integrated scale of development can be considered as an evidence that the sensory integration therapy is effective for language development. This is further substantiated by the considerable increase in effect size in experimental group when compared with control group in receptive language, expressive language, and speech (large effect size). In control group, there was a small increase in effect size in audition and cognition and a moderate increase in receptive language, expressive language, speech, and pragmatic skills.

CONCLUSION

The study concluded that children with CI have sensory processing difficulties. Sensory integration therapy is not only effective in language development but also in other

Table 2: Comparison of Mean Difference and Effect Size on Integrated Scale of Development in the Control and Experimental Group

Components	Control group			Experimental group		
	Mean±SD	Mean difference	Effect size	Mean±SD	Mean difference	Effect size
Audition pre	20.90±5.20	3.6	0.6	14.50±12.11	9.15	0.7
Audition post score	24.50±6.06			23.65±12.10		
Receptive language pre score	37.50±16.03	5.1	0.3	26.75±15.70	15.65	0.9
Receptive language post score	42.60±16.75			42.40±16.03		
Expressive language pre score	26.25±13.08	6.25	0.4	19.60±14.97	14.9	1
Expressive language post score	32.50±12.87			34.50±14.76		
Speech pre	24.00±12.83	5	0.3	17.05±12.75	13.95	1.0
Speech post	29.00±12.73			31.00±13.11		
Cognition pre score	52.95±19.05	3.7	0.1	44.85±20.34	13.7	0.6
Cognition post	56.65±16.78			58.55±16.39151		
Pragmatics pre score	33.55±12.39	0.75	0.06	41.55±16.60525	13.15	0.7
Pragmatics post score	34.30±11.98			54.70±13.93632		

SD: Standard Deviation

Table 3: Comparison of Pre- and Post-Test Scores of Integrated Scale of Development in the Experimental Group

Integrated scale	Test	N	Mean	Mean difference	SD	Z score	Significant (two-tailed)
Audition	Pre	20	14.5000	9.15	12.11133	−3.931	0.000*
	Post	20	23.6500		12.10600		
Receptive language	Pre	20	26.7500	15.65	15.70074	−3.928	0.000*
	Post	20	42.4000		16.03089		
Expressive language	Pre	20	19.6000	14.9	14.97155	−3.923	0.000*
	Post	20	34.5000		14.76304		
Speech	Pre	20	17.0500	13.95	12.75467	−3.926	0.000*
	Post	20	31.0000		13.11889		
Cognition	Pre	20	44.8500	13.7	20.34253	−3.828	0.000*
	Post	20	58.5500		16.39151		
Pragmatics	Pre	20	41.5500	13.15	16.60525	−3.830	0.000*
	Post	20	54.7000		13.93632		

SD: Standard Deviation, *Significance at less than 0.001 level

developmental components, in children with CI. Thus, referral of children with CI to an occupational therapist can be considered. Occupational therapy practitioners working with children with CIs should consider evaluating sensory integration dysfunction in the assessment process. Practitioners should consider over- or under-responsiveness to various types of sensation during the assessment, because these issues may be present in some children with CI.

Study Limitations and Further Research

The study had certain limitations, i.e., to select a better-matched sample in terms of domains of development and sensory processing. CI age was not taken into consideration use of scales which would also include motor components rather than only speech, cognition, and pragmatics. Future studies are needed to evaluate the types of sensory-processing issues in a large sample of children with CI. Exploring the relationship between CI and SPD. VPBIS pattern of sensory integration dysfunction. To use sensory profile (long form) as an outcome measure and to conduct intervention studies.

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