Original Article

Impact of correcting visual impairment and low vision in deaf-mute students in Pune, India

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Aim: The aim of this study was to evaluate visual acuity and vision function before and after providing spectacles and low vision devices (LVDs) in deaf-mute students. **Settings:** Schools for deaf-mute in West Maharashtra. **Methods:** Hearing-impaired children in all special schools in Pune district underwent detailed visual acuity testing (with teachers' help), refraction, external ocular examination, and fundoscopy. Students with refractive errors and low vision were provided with spectacles and LVD. The LV Prasad-Functional Vision Questionnaire consisting of twenty items was administered to each subject before and after providing spectacles, LVDs. **Statistical Analysis:** Wilcoxon matched-pairs signed-ranks test. **Results:** 252/929 (27.1%) students had a refractive error. 794 (85.5%) were profound deaf. Two-hundred and fifty students were dispensed spectacles and LVDs. Mean LogMAR visual acuity before introduction of spectacles and LVDs were 0.33 ± 0.36 which improved to 0.058 ($P < 0.0001$) after intervention. It was found that difference in functional vision pre- and post-intervention was statistically significant ($P < 0.0001$) for questions 1–19. The most commonly reported difficulties were for performing distance task like reading the bus destination (58.7%), making out the bus number (51.1%), copying from blackboard (47.7%), and seeing whether somebody is waving hand from across the road (45.5%). In response to question number 20, 57.4% of students felt that their vision was much worse than their friend's vision, which was reduced to 17.6% after dispensing spectacles and LVDs. **Conclusion:** Spectacle and LVD reduced visual impairment and improved vision function in deaf-mute students, augmenting their ability to negotiate in and out of school.

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Reduced hearing acuity during infancy and early childhood severely retards the development of speech and language skills. Similarly, vision loss early in life has profound functional and psychological implications.[1] Visually impaired children have reduced educational experiences and later, employment opportunities. Early referral and intervention for a vision problem are critical to maintain and improve vision.[2] Functional vision is defined as vision that can be used to perform a task(s) requiring vision – i.e., how a person uses vision.[3]

Because visual and auditory channels together are responsible for more than 95% of information acquisition (tactile, kinesthetic, and olfactory senses playing minor roles), it is crucial to optimize visual function in all hearing-impaired and deaf persons.[4] The situation is further complicated by the fact that it may be more difficult for deaf persons to obtain routine professional services from vision care specialists because of communication problems.

When one of the senses is seriously impaired, the other is used to compensate.[5] As the degree of impairment of one sense organ increases, the role of the remaining sense organ becomes progressively more significant. Thus, the deaf students may compensate by making greater use of visual-perceptual cues than their hearing peers, and thus, even a mild refractive error may reduce the visual cues available to the child. Second, many researchers have reported high incidences of ophthalmologic abnormalities among deaf children compared with the hearing population of the same age.[5-14] However, there have been hardly any study documenting how the children progress after correcting their visual impairment. This study looked at visual problems of deaf-mute students and causes for visual impairment, and also the vision function of these students before and after correction by spectacles and low vision devices (LVDs).

Methods

Permission was sought and obtained from the Ethical Committees of Lions NAB Eye Hospital, Miraj, India, and Bharti Vidyapeeth Medical College, School of Optometry, Pune, India. The office of the commissioner for disability Maharashtra state was contacted to collect information about special schools for deaf-mute in Pune district (urban and rural). A list of 17-special education schools for hearing impairment in Pune district was included in the study. Permission has been sought from the principals of the schools in 2012.

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Parents and children were informed about the forthcoming eye examination at least 2 days before the screening, and the consent forms are distributed for getting them duly signed by their parents or guardians. In 2012–2013, their students were examined using a "Life line mobile eye clinic," a bus equipped with chair unit, vision drum, slit lamp, auto-refractometer with keratometer, streak retinoscope, fundoscope, trial box and trial frame, and an audiometer.

Each child's hearing and speaking ability were recorded as reported by the teachers, along with the cause and type of deafness. The hearing ability was measured in decibels. Hearing loss 25–40 db classified as mild, 41–60 db as moderate, 61–80 db as severe, and 81–100 db as a profound deafness as per the World Health Organization norms. The children were examined with the help of school teacher for interpreting the sign language responded by the children.

Those with a significant refractive error were dispensed spectacles in January–March 2013. Those whose visual acuity could not improve up to 6/60 were dispensed low vision aids on August–September 2013. Each student was followed up after spectacle and low vision aid dispensing in 2014. Before dispensing low vision aids and/or spectacles, the children were administered the LV Prasad-Function Vision Questionnaire (LVP-FVQ).[3] The LVP-FVQ's Marathi (the regional language) version used in the Miraj Pediatric Cataract study was used for the present study.[15] Children more than 10 years of age were asked to complete the questionnaires themselves with help for a teacher and an optometrist if required. For younger children, their parents were asked to complete the questionnaire with the child and special education teacher by their side. The LVP-FVQ consisting of twenty items was administered to each subject before and after providing spectacles and low vision aids. The questionnaire has 19 questions designed to cover four domains: distance vision (six), near vision (six), color vision (two), and visual field (five) [Appendix A]. An additional question number 20 was related to global self-assessment of the child's vision as compared with his or her friends with normal vision.

Nonnumerical vision was arbitrarily assigned a LogMAR value for statistical purposes. Counting finger close to face = LogMar 1.70, hand motion = LogMAR 2.00, intact light perception = LogMAR 2.30, defect light perception = LogMAR 2.70, and no light perception = LogMAR 3.00.[16] Myopia was defined as the magnitude ≤−0.50 diopter, hyperopia ≥+1.00 diopter while astigmatism ≥0.50 diopter.

The initial magnification power used for telescopes was predicted from the ratio of the denominator of the measured visual acuity to denominator of the desired visual acuity. For LVDs for near, the required addition was initially determined using the Kestenbaum's rule (using the reciprocal of the distance visual acuity to calculate the dioptric power of the addition) and the ratio rule (comparing near visual acuity to target acuity).

Excel sheet was used for data entry and the data were analyzed by Statistical Package for Social Science version 16 (IBM, Bangalore, India). Wilcoxon matched-pairs signed-ranks test was introduced to test the statistical significance of the median of the difference between pre- and post-questionnaire.

Results

Nine hundred and forty-seven students aged 4–21 years, enrolled in the 17 schools for the deaf-mute in Pune district, were to be examined; however, we could examine only 929 who were present at the time of the visit. 560/929 (60.3%) were male. Twenty-six had acquired deafness (acquired between 2 and 6 years of age), of which 21 were male ($P = 0.021$), rest 903 had congenital deafness. Five (0.5%) were mild, 23 (2.5%) moderate, 107 (11.5%) severe, and 794 (85.5%) were profound deaf. Their ages were 46 (5%) ≤5 years, 325 (35%) 6–10 years, 391 (42%) 11–15 years, and 167 (18%) ≥16 years.

Refractive errors were present in 252 (27.1%) students, but only 16 were using appropriate spectacle correction at presentation. Other ocular conditions included exo or eso tropia in 16 (1.7%), eso or exophoria in 38 (4.1%), nystagmus 10 (1.1%), amblyopia 9 (1%), color vision deficiency 21 (2.3%), blue iris 12 (1.3%), cataract 3 (0.3%), iris heterochromia 5 (0.5%), and 4 (0.4%) retinal dystrophies. 15 (1.6%) had eyelid problems, 30 (3.2%) conjunctival abnormalities, and 8 (0.9%) had microcornea. 42 (4.5%) gave history of nyctalopia.

Of these 252 students, 250 students were dispensed spectacles. Their age ranged from 8 to 18 years (mean of 12.22 ± 3.11 years), and 137 (54.8%) were boys. Two children had moved by the time we dispensed spectacles. 224 eyes were myopic, 58 had compound myopic astigmatism, 96 simple myopic astigmatism, 86 hypermetropia, 26 simple hyperopic astigmatism, 8 compound hyperopic astigmatism, and 6 mixed astigmatism. Among the 250 students, none were mildly hearing impaired (hearing loss <40%), 8 (3.2%) were moderately hearing impaired (hearing loss 41%–60%), 29 (11.6%) were severely hearing impaired (hearing loss 61%–80%), while 213 (85.2%) were profound hearing impaired (hearing loss >81%). Their corrected visual acuity was 210 (84%) >6/18, 23 (9.2%) 6/60–6/24, 13 (5.2%) <6/60–3/60, and 4 (1.6%) <3/60. There was no difference in refractive errors between congenital and acquired deafness ($P = 0.967$), but the more profound deaf had more ocular abnormalities ($P = 0.034$).

Thirteen students among them were dispensed LVD, 12 for distance (×3 to 6 students, ×4 to 4 students and ×5 to 2 students), while LVDs for near (×4 stand magnifiers) were given to 3 students. Two were given both near and distance LVDs.

Pre- and post-LVP-FVQ were successfully administered to 235 students as 15 students missed follow-up visit done after 6 months. One school with 15 children had closed and we could not trace its students who had migrated to other schools.

The mean LogMAR visual acuity before the introduction of spectacles and LVDs was 0.33 ± 0.36. After intervention, visual acuity was improved significantly to 0.058 ($P < 0.0001$). The mean LogMAR visual acuity in 13 children, who were given LVDs, has been improved to 0.26 ± 0.137 which were 1.02 ± 0.30 at the base level ($P = 0.0002$) [Fig. 1].

It was found that difference in functional vision pre- and post-intervention was statistically significant ($P < 0.0001$) for all the 19 questions in students' dispensed spectacles [Table 1]. The most commonly reported difficulties in this study were related to performing distance task like reading the details on the bus such as its destination (58.7%), making out the

bus number (51.1%), copying from blackboard (47.7%), and seeing whether somebody is waving hand from across the road (45.5%). In response to question number 20, 57.4% of students felt that their vision was much worse than their friend's vision, which was reduced to 17.6% after dispensing spectacles and LVDs.

There was statistically significant difference in functional vision pre- and post-LVD, with those activities related to their studying/reading lifestyle like copying from the blackboard ($P = 0.0005$), reading textbook at arm's length ($P < 0.01$), and in certain other generalized activities like making out whether the person is seen across the road is boy or girl, seeing whether somebody is calling by waving his or her hand from across the road and reading the bus number or the other details on the bus [Table 2].

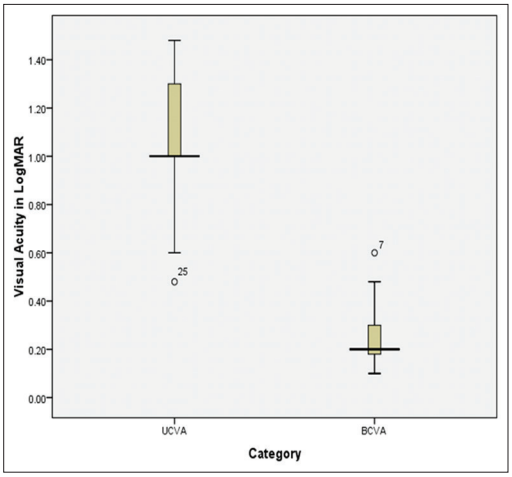

Figure 1: Vision before and after giving low vision aids

Discussion

Numerous studies have documented that the prevalence of ocular problems and visual impairment is more common in deaf-mute children as compared to their normal hearing peers, but few document the actual improvement in their visual acuity and vision function after treatment. Few studies have documented an improvement of visual acuity in children with low vision, following the use of LVDs.[17-20] However, these were done in children with low vision with the absence of any other disability. Our study is the first of its kind where we have assessed functional vision in deaf and mute children who depend on their vision more to learn and interact with their environment. As there was no special functional vision questionnaire available for deaf and mute children, we have used LVP-FVQ to measure the improvement in functional vision performance in deaf and mute children with visual impairment. It was a challenge to interview the special children although the teachers who knew sign language helped in explaining the questionnaire to the children. There is a requirement for formation of separate functional vision questionnaires for deaf and mute children as some of the questions were difficult to make them understand only by sign language. Other questionnaires such as NEI VFQ-25 or the low vision quality-of-life questionnaire could be adapted for this.[21,22]

In this study, the functional vision of mild visual impaired children was not affected much; however, the children with moderate to severe visual impairment and blindness were having reduced visual function like the results from the study from Kariapatti in South India.[23] Most commonly reported difficulties were related to performing distance vision task like recognizing bus number and the details on the number plate, copying from blackboard, and seeing whether someone is waving hand across the road.

Table 1: Comparison of LVP-FVQ scores before and after providing Spectacles and Low Vision Devices

Q No	Pre-Q		Post-Q		Difference		*P*
	Mean±SD	Median	Mean±SD	Median	Mean±SD	Median	
1	0.685±1.080	0.00	0.080 ± 0.329	0.00	0.604 ± 1.022	0.00	<0.0001
2	0.906±1.169	0.00	0.114 ± 0.329	0.00	0.791 ± 1.027	0.00	
3	0.472±0.878	0.00	0.089 ± 0.352	0.00	0.380 ± 0.766	0.00	
4	0.770±1.037	0.00	0.251 ± 0.704	0.00	0.519 ± 0.807	0.00	
5	0.842±1.127	0.00	0.076 ± 0.324	0.00	0.766 ± 1.046	0.00	
6	1.051±1.297	1.00	0.144 ± 0.519	0.00	0.906 ± 1.125	1.00	
7	1.247±1.380	1.00	0.212 ± 0.754	0.00	1.034 ± 1.147	0.00	
8	0.663±1.014	0.00	0.114 ± 0.461	0.00	0.548 ± 0.862	0.00	
9	0.506±0.898	0.00	0.119 ± 0.395	0.00	0.387 ± 0.749	0.00	
10	0.621±1.000	0.00	0.195 ± 0.510	0.00	0.425 ± 0.749	0.00	
11	0.548±1.017	0.00	0.085 ± 0.333	0.00	0.463 ± 0.868	0.00	
12	1.179±1.595	0.00	0.706 ± 1.406	0.00	0.463 ± 0.892	0.00	
13	0.319±0.787	0.00	0.072 ± 0.432	0.00	0.246 ± 0.639	0.00	
14	0.310±0.728	0.00	0.046 ± 0.248	0.00	0.263 ± 0.665	0.00	
15	0.225±0.609	0.00	0.038 ± 0.213	0.00	0.187 ± 0.538	0.00	
16	0.378±0.908	0.00	0.110 ± 0.574	0.00	0.268 ± 0.698	0.00	
17	0.166±0.571	0.00	0.051 ± 0.316	0.00	0.114 ± 0.452	0.00	
18	0.161±0.554	0.00	0.038 ± 0.250	0.00	0.123 ± 0.450	0.00	
19	0.370±0.747	0.00	0.106 ± 0.404	0.00	0.263 ± 0.597	0.00	
20	1.234±0.751	1.00	1.804 ± 0.493	2.00	-0.57±0.678	0.00	

Table 2: Comparison of pre and post LVP-FVQ scores in 13 children who were given LVDs

Q No	Pre-Q		Post-Q		Difference		*p*
	Mean±SD	Median	Mean±SD	Median	Mean±SD	Median	
1	3.077±0.954	3.00	0.692±0.751	1.00	2.385±1.121	3.00	*p*=0.0005
2	3.308±1.082	4.00	1.000±1.000	1.00	2.308±1.182	2.00	*p*=0.0005
3	2.154±1.088	2.00	0.769±0.926	1.00	1.385±0.960	2.00	*p*=0.0020
4	2.385±1.387	0.00	1.846±1.676	0.00	0.538±1.276	0.00	*p*=0.1250
5	3.000±0.307	3.00	0.307±0.630	0.00	2.692±1.182	3.00	*p*=0.0005
6	3.231±1.013	4.00	0.769±0.832	1.00	2.462±1.198	2.00	*p*=0.0005
7	3.538±0.877	4.00	1.231±1.423	1.00	2.308±1.182	2.00	*p*=0.0005
8	2.154±1.573	3.00	1.154±1.281	1.00	1.000±1.080	1.00	*p*=0.0156
9	1.846±1.573	2.00	0.923±1.030	1.00	0.925±1.000	1.00	*p*=0.0195
10	1.769±1.589	2.00	0.923±1.038	0.00	0.846±1.214	0.00	*p*=0.0313
11	1.538±1.561	2.00	0.538±0.877	0.00	1.000±1.225	0.00	*p*=0.0313
12	2.846±1.951	0.00	2.692±2.016	0.00	0.153±0.375	0.00	*p*=0.500
13	1.385±1.261	2.00	0.461±0.776	0.00	0.923±1.188	0.00	p=0.0313
14	1.385±1.261	2.00	0.461±0.776	0.00	0.923±1.188	0.00	*p*=0.0313
15	0.923±1.256	0.00	0.461±0.660	0.00	0.461±0.776	0.00	*p*=0.125
16	1.923±1.754	0.00	1.154±1.573	0.00	0.769±1.363	0.00	p=0.125
17	1.154±1.281	0.00	0.846±1.068	0.00	0.307±0.630	0.00	p=0.250
18	1.154±1.214	0.00	0.692±0.854	0.00	0.461±0.660	0.00	p=0.0625
19	1.615±1.502	0.00	1.000±1.155	0.00	0.615±1.044	0.00	*p*=0.125

Another important finding was that none of the children had received any specialist's support earlier. Refractive error was the main cause of visual impairment in deaf-mute students and was much more prevalent than normal students in Pune district.[24] Ophthalmic evaluations needed to be repeated on a periodic basis to help achieve and maintain maximum possible vision function in these special children who depend on the sense of sight even more than normal children.

Limitations of the study

We found that many of the students were not able to grade their difficulties. Skill of some of the teachers in the interpretation of sign language was not high. Introducing a single sign language interpreter for all the children would have increased the validity of the study, but teachers had better rapport with their students. El Byoumi and Mousa reported that this could be because most children had visual impairment since birth or early childhood and thus could not judge the level of severity.[25] A newer version of the LVP-FVQ was published after the data collection was complete and thus could not be used.[26]

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Conflicts of interest

There are no conflicts of interest.

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Appendix

Appendix A: L.V.Prasad Child Vision Function Questionnaire

Name of Child:

Responses for each item rated on a 5-pointLikert scale.

0 = No difficulty

1 = Little difficulty (25%, *char anna*)

2= Some difficulty (50%, *aath anna*)

3= Great difficulty (75%, *bara anna*)

4= Unable to perform the task due to visual reasons (100%, *rupayya*)

9 = Not applicable

1. Do you have any difficulty in making out whether the person you are seeing across the read is a boy or a girl, during the day?

   0 1 2 3 4

2. Do you have any difficulty in seeing whether somebody is calling you by waving his or her hand from across the road?

   0 1 2 3 4

3. Do you have difficulty in walking alone in the corridor at school without bumping into objects or people?

   0 1 2 3 4

4. Do you have any difficulty in walking home at night (from tuition or a friend's house) without assistance when there are streetlights?

0 1 2 3 4

5. Do you have any difficulty in copying from the blackboard while sitting on the first bench in your class?

0 1 2 3 4

6. Do you have difficulty in reading the bus numbers?

0 1 2 3 4

7. Do you have any difficulty in reading the other details on the bus (such as its destination?)

0 1 2 3 4

8. Doyou have any difficulty in reading your textbooks at an arm's length?

0 1 2 3 4

9. Do you have any difficulty in writing along a straight line?

0 1 2 3 4

10. Do you have any difficulty in finding the next line while reading when you take a break and then resume reading?

0 1 2 3 4

11. Do you have any difficulty in locating dropped objects (pen, pencil, eraser) within the classroom?

0 1 2 3 4

12. Do you have any difficulty in threading a needle?

0 1 2 3 4

13. How much difficulty do you have indistinguishing between 1rupee and 2 rupee coins (without touching)?

0 1 2 3 4

14. Do you have difficulty in climbing up or down stairs?

0 1 2 3 4

15. Do you have difficulty in lacing your shoes?

0 1 2 3 4

16. Do have difficulty in locating a ball while playing in the daylight?

0 1 2 3 4

17. Do you have difficulty in applying paste on your toothbrush?

0 1 2 3 4

18. Do you have difficulty in locating food on your plate while eating?

0 1 2 3 4

19. Do you difficulty in identifying colors (e.g., while coloring)?

0 1 2 3 4

20. How do you think your vision is compared with that of your normal-sighted friend?

Do you think your vision is:

As good as your friend's 0

A little bit worse than your friend's 1

Much worse than your friend's 2

End of Questionnaire

The questionnaire was based on four parameters: Distance vision (Q 1,2,4,5,6,7), near vision (Q 8,9,10,12,13,15), color vision (Q 17,19) , field of vision (Q 3,11,14,16,18)