ISSN: 0976-3031

Available Online at http://www.recentscientific.com

International Journal of Recent Scientific Research
Vol. 7, Issue, 12, pp. 14640-14649, December, 2016

International Journal of Recent Scientific Research

Research Article

LOW VISION AIDS IN CHILDREN: PROFILING AND EFFECTIVITY

Nitasha Ahir[1] and Kirti singh[2]

[1]G.G.S Medical College, Faridkot
[2]Guru Nanak Eye Centre, New Delhi

ARTICLE INFO

Article History:

Received 15th September, 2016
Received in revised form 25th October, 2016
Accepted 23rd November, 2016
Published online 28th December, 2016

ABSTRACT

Introduction: A person with low vision has impairment of vision even after treatment and/ or standard refractive correction with a visual acuity ranging from 6/18 to light perception in the better eye, or a visual field of less than 10° from the point of fixation, but who uses, or is potentially able to use, vision to plan and /or execute a task. The types of visual impairment in patients of low vision are: disabled central vision (reading vision), disabled/partial peripheral vision, disabled/partial colour vision, disabled/partial ability to adjust to different light settings and disabled/partial ability to adjust to different contrasts/glare. Fortunately, many of these visual disabilities are amenable to treatment with low vision aids. **Material And Methods:** Thirty five children suffering from low vision (BCVA <6/18 and/or visual field of less than 10° from the point of fixation) attending the Out Patient Department and the Paediatric Ophthalmology Clinic of Guru Nanak Eye Centre, New Delhi were included in this prospective study. After their best medical and surgical treatment, patients were then referred to the Low Vision Aids Clinic for the training and provision of Low Vision Aids. Patients were enrolled between October 2011 to February 2013 after taking an informed consent. The mean length of follow-up was minimum of 1 month.

Results: This study ascertains the need and effectiveness of visual rehabilitation with low vision aids in children with low vision. Use of various optical and non optical devices helps such children to read their textbooks, improve their reading speed and comprehension rate as well as change their quality of life. Low vision aids improved visual acuity, both distance and near. Children who gained better visual acuity had significant improvement in reading speed and comprehension rate. It also had a significant effect on their quality of life; enabling them to read the textbooks, use mobile phones, read blackboard, watch television, go out alone in daylight, chat with friends and recognising them at a distance. Children with better visual acuity required lesser magnification of visual aids and showed more improvement than those with poor visual acuity. Contrast sensitivity was decreased in these low vision children and it did not show much improvement after the use of LVA. Visual field was restricted in these children both by nature of disease (retinitis pigmentosa, glaucoma, optic atrophy, microphthalmos) and by use of high plus spectacles. Major causes of low vision were retinal diseases, thereby suggesting family history as an important risk factor. Significant improvement in near vision proves visual rehabilitation an important and successful measure.

Conclusion: Low vision is a major public health problem in our country and when transacted onto the children, it demands a special attention. Early visual rehabilitation in children reduces their blind years and helps them live an independent and near normal life. This study ascertains the need and effectiveness of visual rehabilitation with low vision aids in children with low vision.

INTRODUCTION

A person with low vision has impairment of vision even after treatment and/ or standard refractive correction with visual acuity ranging from 6/18 to light perception in the better eye, or a visual field of less than 10^0 from the point of fixation, but who uses, or is potentially able to use, vision to plan and /or execute a task.[1] The types of visual impairment in patients of low vision are: disabled central vision (reading vision), disabled/partial peripheral vision, disabled/partial colour vision, disabled/partial ability to adjust to different light settings and disabled/partial ability to adjust to different contrasts/glare.[3] Fortunately, many of these visual disabilities are amenable to treatment with low vision aids. Use of optical,

**Corresponding author: Nitasha Ahir*
G.G.S Medical College, Faridkot

non-optical devices combined with training in adaptive skills helps such people utilize their residual vision so that they can function as normal sighted individuals in most of daily life situations.[6]

MATERIALS AND METHODS

Thirty five children suffering from low vision (BCVA <6/18 and/or visual field of less than 10^0 from the point of fixation) attending the Out Patient Department and the Paediatric Ophthalmology Clinic of Guru Nanak Eye Centre, New Delhi were included in this prospective study. After their best medical and surgical treatment, patients were then referred to the Low Vision Aids Clinic for the training and provision of Low Vision Aids. Patients were enrolled between October 2011 to February 2013 after taking an informed consent. The mean length of follow-up was minimum of 1 month.

Inclusion criteria:	Exclusion criteria:
Children of age group 5 to 15 years.	Children with additional impairments e.g. hearing defect, delayed motor and cognitive development.
Children with best corrected visual acuity (BCVA) of less than 6/18 with Snellen's E-chart in better eye	Children with prior experience or usage with low vision aids.
Children willing to use Low Vision Aids and for follow-up at least 1 month.	
Children who could read and write partly or those enrolled/ wishing to be enrolled in schools.	

At the initial visit, baseline information including patient's age, gender, educational status, detailed history was recorded from the patient/attendant. Patients then underwent a standard ophthalmological examination- visual acuity both distance and near, cycloplegic refraction, contrast sensitivity, visual field, slit lamp bio microscopy, retinal examination followed by the prescription of low vision aids. A quality of life questionnaire was filled up by the child or the parents at the initial visit in a face to face interview and then again after 1 month after use of the requisite Low Vision Aid to assess the impact of the visual aid on patient's quality of life.

Distance visual acuity was assessed using a Snellen's tumbling E- chart. If the child was unable to fixate and respond to Snellen chart then low vision distance chart at 3 m was used. Near vision was assessed with log MAR chart with five tumbling-E optotypes in each line. The eye with better vision was tested first and in case of equal vision, the right eye was tested first both with and without the use of requisite spectacles. The cut-off for Low Vision Aid assessment for near was chosen to be N10 as this is the size of print in text books used in primary education in our country. Functional vision was assessed by determining the navigation ability of the child through two chairs placed 1m apart in a well-lit room.

Cycloplegic refraction was performed under 1% atropine ointment applied three times a day for three days OU for children less than 10 years of age. For children aged > 10 years, 2% homatropine was used as cycloplegic. One drop was used three times at the interval of 10 minutes. Cycloplegia was considered complete if the pupillary light reflex was absent. Again the eye with better vision was tested first; in case of equal vision, the right eye was tested first. Post Mydriatic test was done at 2 weeks (in case of atropine) and at 1 week (in case of homatropine).

Contrast sensitivity was measured by F.A.C.T chart. This chart evaluates patient's vision over a range of size and contrast which closely simulates their normal environment. Visual Field assessment was done using the simple confrontation method. The patient was aligned at the same eye level on a level platform.

Slit lamp biomicroscopy and fundus evaluation by direct or indirect ophthalmoscopy was done to delineate the cause of low vision.

Before the prescription of LVA's and training in the use of LVA's, a detailed discussion with the patients' care giver/ parent was done to assess the patients' visual needs and subsequently the trial of Vision aids was planned. They were explained both the advantages and limitations with the use of LVA's.

The first option offered to the children was aspheric high power spectacles. Only if these failed to provide adequate magnification for near/ distance vision other LVA's were tested. In the later scenario the device which enhanced vision appropriately and best suited the child's need was prescribed.

Magnification requirement for the distance was calculated by the Kestenbaum formula which is the inverse of measured distance visual acuity. For example, if the patients' best corrected distance visual acuity in the better eye is 6/36, then the required magnification for distance is 36/6 = 6 X.

Required magnification for near tasks was calculated as:

Equivalent viewing power (EVP) =

$$\frac{\text{Best Corrected Visual Acuity}}{\text{Target Visual Acuity}} \text{ X } \frac{100}{\text{Working Distance in cm}}$$

For example, if the patients' near vision recorded is N36; then the target visual acuity required to let him read the print of textbook at a distance of 30 cm will be N10.

Therefore, EVP = (36/10) x (100/30) = 12 D. The X of the device needed is obtained by dividing the D by figure 4, resulting in = 3 X.
The low vision aid was chosen by a trial done under standard indoor lighting conditions to simulate patients' home/class background.

According to the magnification requirement, the appropriate low vision aid was tested and prescribed after requisite training which was tailored to the patients' capability. Children and/ parents were instructed on the adequate handling of the prescribed low vision aid and were asked to read using it for at least 30 minutes.

The parameters evaluated were

a. Reading speed (words per minute – wpm): This was evaluated before and after the provision of low vision aids. Near work efficiency was evaluated using standardized reading texts and school books.

For the ease of analysis, reading ability is classified into four groups based partly on Trauzettel-Klosinski classification.[42]

Fluent reading	>70 wpm
Struggling reading	30-70 wpm
Spot reading	11-30 wpm
No reading	<10 wpm

b. Comprehension rate (ratio of correct responses when using the aid versus not using the aid), was also assessed before and after the provision of low vision aids.

Criteria of success were defined as:
Primary outcome: Improvement in near vision to N10.

Secondary outcomes

1. Improvement in reading speed and /or
2. Improvement in comprehension of written text at distance and near and/or
3. Improvement in number of lines read.

The Cardiff Visual Ability Questionnaire for Children (CVAQC) was used to assess the quality of life in children (after obtaining permission from authors). This is a short, psychometrically robust and self- reported instrument that gives unidimensional scale for the assessment of the visual ability in children and young people with a visual impairment.[43] It consists of 25 item questionnaire, but only 17 of them were used in our study as being relevant to the Indian context.

Due to the patients' visual impairment, the children themselves were not asked to fill the questionnaire. Instead, their parents were interviewed by one person conducting the study who then filled the questionnaire. Each question was grouped into five categories assessing the quality of life in each aspect [1] Education (four questions) [2] Near Vision (four questions) [3] Distance Vision (three questions) [4] Getting around (three questions) [5] Social Interaction (three questions). Responses were scored on a scale of 1-6, where 1= Very easy, 2= Easy, 3= Difficult, 4= Very Difficult, 5= Impossible or can't do because of my eye sight, 6= Don't do for other reasons. The answers to all the items were given a score and the total score was added before and after the use of LVA. The least score (17) denoted the excellent quality of life and the maximum score (102) denoted the poor quality of life. For the ease of analysis, the scores were grouped into five categories: 17-34, 35-52, 53-69, 70-86, 87-103; depicting the excellent, very good, good, fair and poor quality of life.

OBSERVATIONS AND RESULTS

Age and gender

We enrolled 35 children with 66 eyes of age group 5 to 15 years in our study of low vision in children. Four of them were one eyed. Of the 35 children, 25 were males (71.4%) and 10 were females (28.6%) [Figure1]. The mean age of the patients was 10.86 years, with maximum number of patients falling in the age group of 12 to 15 years (45.7%), 13 (37.2%) in the age group of 8 to 12 years whereas the number of patients in the age group of 5 to 8 years were only 6 i.e. 17.1 % of the study group as illustrated in Table no.1.

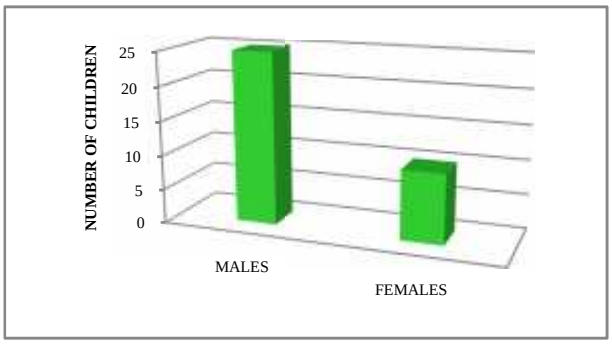

Figure 1 Gender distribution among patients

Table No. 1 Age distribution

Age Group	Number of Children
5 TO 8 YRS	6
8 TO 12 YRS	13
12 TO 15 YRS	16

Period of Gestation

Of these children, full term children were 23 (65.7%) and number of preterms, born on or before 8 months of gestation were 12 (34.3%).

Locality of Patients

Out of the 35 patients enrolled in the study, 23 belonged to the urban locality (65.7%) and only 12 of them belonged to the rural locality (34.3%) from the villages in the vicinity of NCT Delhi. [Figure 2]

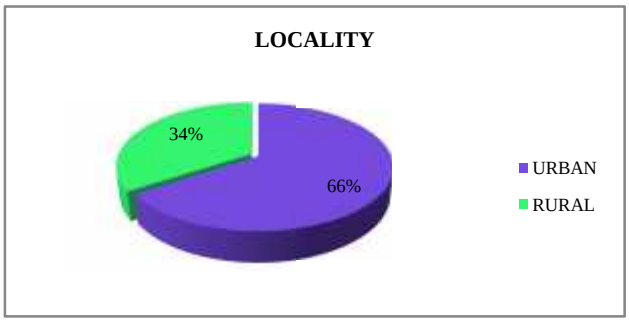

Figure 2 Locality of the patients

Educational Status of Children

All the children enrolled in the study were going to school. The distribution of the number of children in various categories of level of education is shown in Table No.2.

Table No. 2 Distribution of No. of children according to the level of education

Level of education	Number of children
Nursery to UKG	7
1st to 5th class	14
6th to 10th class	14

All the children were going to regular schools except for three; one with microphthalmos with colobomata and other two with buphthalmos, who were receiving integrated education. In an integrated education system, the visually challenged and sighted children study in the same school. They attend classes together, as well as participate in sports, cultural events and other activities.

Educational Status of Parents

Of the 35 children of the study group, the father figure in 13 was illiterate and in 15 the mother was illiterate. In the rest, the education levels of parents ranged from high school to post graduation. The distribution is shown in Figure 3.

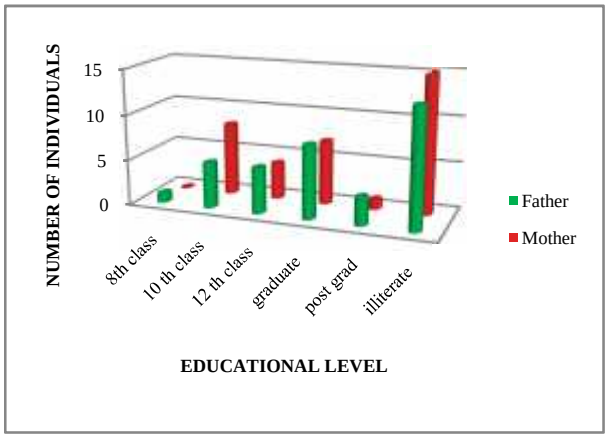

Figure 3 Educational Status of Parents

Causes of Low Vision

The various causes of low vision in different age groups of children are listed in Figure 4. Both eyes of the children were affected with same etiology responsible for low vision.

The major causes of Low Vision in our study in order of frequency were Heredomacular Degeneration (17.2%), Optic Atrophy (17.2%), Primary/ Secondary Glaucoma (14.3%), Retinitis Pigmentosa (11.4%), Aniridia (8.6%).

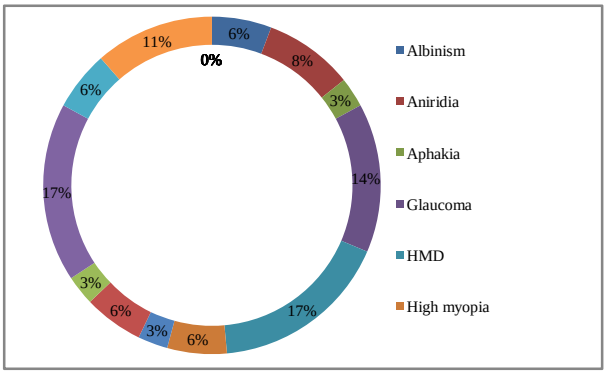

Figure 4 Causes of Low Vision

Nystagmus was seen in twelve of the patients, accounting for the most common associated disorder. Primary optic atrophy was seen in four children and consecutive optic atrophy (post optic neuritis) in one. In the follow up period after prescription of LVA, one child with Both Eyes operated Glaucoma Filtration Surgery (GFS) developed cataract, requiring lens extraction and one child with aphakia developed secondary glaucoma.

Distance Visual Acuity

In the study group, the average best corrected distance visual acuity was 1.3± 0.5 (mean±SD) LogMAR (Snellen 3/60) with range of 0.6 to 2.0 Logmar (Snellen 6/24 to 6/200). Post prescription of distant LVA the mean visual acuity improved to Logmar 1.0±0.24 (Snellen 6/60). This improvement was significant at a p-value of 0.004 (paired t-test).

Before provision of LVA's, range of distant visual acuity in all children varied from 0.6 to 2.0 (6/24 to 6/200), with median of 1.3. Around 25 % of patients had vision below 1.1 (6/75) & 75% of patients had vision below 2.0 (6/200). After provision of LVA's, range varied from 0.5 to 2.0 (6/18 to 6/200), median shifted to 1.1 (6/75).

The mean distant visual acuity of 66 eyes (35 children) was 1.55±0.5 (mean± SD) before the use of LVA which improved to 1.04±0.48, with a significant p-value of 0.003 on paired t-test. The upper limit & lower limit 95% CI shifted to 1.16-0.92 after the use of LVA from initial value of 1.66-1.43. The median & IQR before the use of LVA was 1.65, 0.92 and after the use of LVA was 1.0, 0.70 respectively. This is depicted in Figure 5.

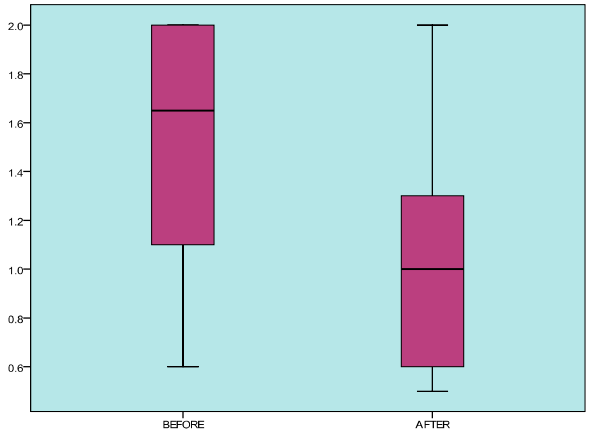

Figure No.5 Box Plot showing Pre & Post Distant VA in 66 eyes

Near Visual Acuity

For the ease of analysis, we arbitrarily divided the near visual acuity into 3 groups. Near VA between N6-N12 was graded as ***better***, VA between N18 – N36 was graded as ***moderate*** and near VA < N36 was graded as ***poorer***. At the initial visit, only 1 (2.8%) of them had *better* near VA, none had *poorer* VA and 34 of them (97.2%) had *moderate* visual acuity. The **one** patient with *better* Near VA was the case of B/E Pseudophakia operated for congenital cataract at the age of 6 months. Out of the 34 patients with *moderate* near VA, 11 (32.4%) improved by 1-2 lines and 23 (67.6%) improved by 3-4 lines.

After the provision of Low Vision Aids (LVA's), 28 of them (80%) attained better VA and 7 of them (20%) could attain moderate VA. This is depicted in Figure 6.

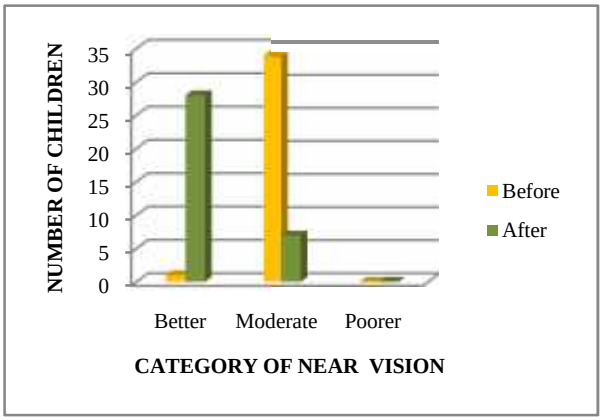

Figure 6 Distribution of patients in each category before and after LVA

Near visual acuity improved in all 35 children significantly after provision of low vision aids, to 10.2±4.3 (mean±SD) from pre visual aid of 29.14±8.8. On application of paired t-test, the p-value was 0.034, which assumes significance.

On analysing vision for individual eyes (66 eyes), mean near vision was 28.13±8.9 before use of LVA which improved to 9.68±3.97 after provision of LVA which assumes significance with p-value of 0.002 (paired t-test).

Primary outcome of success in our study was defined as the attainment of near vision N10, as this is the size of text used in school books in our country. These children who could read upto N10 would be considered eligible for regular screening. The number of children who attained this primary outcome post LVA were 24 (68.6%) whereas; 11 of them (31.4%) could not achieve this goal. The distribution of patients in each category of near vision before and after the use of LVA's is depicted in Table No. 8 and graphically in Figure 7. Since the number of children having near vision N10 before provision of LVA's were zero, p-value could not be obtained for this test; however the result itself of 24 children reading N10 after provision of LVA's was felt to be a highly significant finding.
On questioning them how they were managing to read in schools before the use of LVA, it was found that these children were taught by separate print of texts in large font size or by verbal communication.

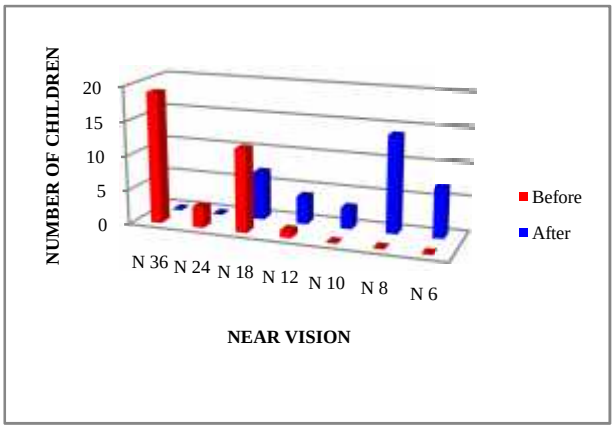

Figure 7 Distribution of patients in each category of Near VA before & after the use of LVA

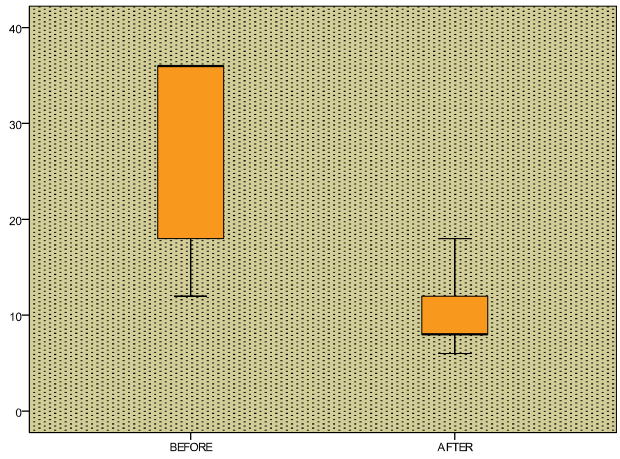

Figure 8 Box Plot showing Near Visual Acuity before and after the use of LVA

Before use of LVA's, near visual acuity varied from N36 to N12, with 25% of patients having vision of < N18 & both median vision and 75th percentile of N36. After provision of LVA's, the range narrowed down to N18 - N8, with 75% of patients reading better than N12 and with median & 25th percentile coinciding at N8. This is shown in Figure 8.

Contrast Senstivity

Contrast sensitivity measures the ability to see details at low contrast levels. It is the reciprocal of the contrast at threshold, i.e., one divided by the lowest contrast at which forms or lines can be recognized. Visual information at low contrast levels is particularly important in communication, since the faint shadows on faces carry the visual information related to facial expressions; in orientation and mobility, where we need to see critical low contrast forms as the curb, faint shadows, and stairs when walking down. In traffic, the demanding situations are at low contrast levels, for example, seeing in dusk, rain, fog, snow fall, and at night; in everyday tasks, where there are numerous visual tasks at low contrast, like pouring coffee into a dark mug; in near vision tasks like reading and writing, if the information is at low contrast as in poor quality copies.

Patients at initial visit had markedly low contrast sensitivity due to their decreased vision. After provision of Low Vision Aids, no significant improvement in contrast sensitivity occurred, as could be expected, as the optical aids dispensed did not target improvement in contrast sensitivity. The contrast sensitivity function was in mid-spatial frequencies (3, 6 cycles per degree) in all subjects with a range of 16 to 45 before the use of LVA which improved slightly to 12 to 45 after use of LVA. The relationship in contrast sensitivity pre and post LVA use in 66 eyes is depicted in Figure 9.

In this study involving 66 eyes, Pre LVA mean was 24.52±7.6 (95%CI 26.4-22.7) with median & IQR 23 & 17. Post LVA, mean was 26.74±8.4 (95%CI 28.8-24.6) with median & IQR 23 & 13.

Refraction

Patients' distance and near vision was noted after refractive correction. The values ranged from -26 to +14 DS for distance. In our study, myopes were 22 in number (62.8%) and13 (37.2%) were hypermetropes.

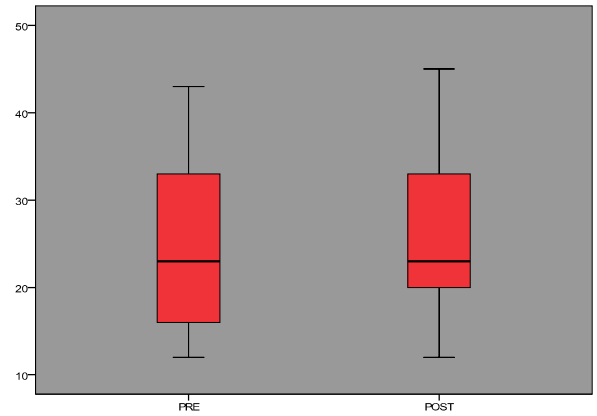

Figure 9 Box plot showing contrast sensitivity in 66 eyes pre & post LVA

Visual Field

The visual field done by confrontation method was arbitrarily divided into three categories: 1) well preserved visual field, with automated perimetry possible, 2) restricted visual field with automated perimetry not possible and 3) severely restricted visual field. The distribution of children in various categories is shown in Figure 10. These categories were mutually exclusive**.**

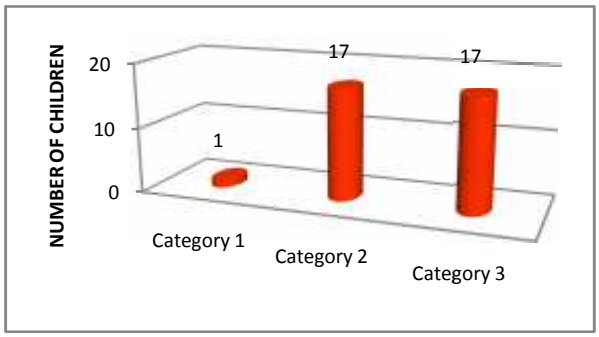

Figure 10 Distribution of children according to the category of visual field

Type of Low Vision Aids

The Low Vision Aids prescribed to the children to improve their near vision were mainly aspheric spectacles to help them in reading. Aspheric lenses utilized in high refractive error, have a more complex front surface that gradually changes in curvature from centre of the lens out to the edge that helps to reduce spherical aberrations. They are featured as light weight thinner lenses which give sharp vision and distort the viewer's eyes less as seen by other people, thus, producing better aesthetic appearance without compromising the optical performance. Otherwise the spherical aberrations inherent with conventional high plus lenses would be very bothersome to the wearer. The refractive power of these spectacles was mainly +4 DS, +6 DS, +8 DS and +12 DS. The distribution of these spectacles is depicted in Table No.3

Table No. 3 Distribution of refractive power of aspheric spectacles

Refractive Power	No. of Children
+4 DS	1 (2.8%)
+6 DS	9 (25.7%)
+8 DS	5 (14.3%)
+12 DS	20 (57.2%)

Telescopes were given only to those who could accept them. Only seven children of the study group accepted telescope. The telescopes accepted were mainly uniocular, usually 10 X, spectacle mounted. The children were advised to use them while looking at the blackboard. They were instructed to move their head instead of their eyes while using them to maintain their field of vision. The children who accepted telescope were suffering from optic atrophy (3), heredomacular degeneration (3), retinitis pigmentosa (1). None of them had nystagmus. The improvement documented after the use of telescope was change in mean distance visual acuity from LogMAR 1.4 (6/150) to LogMAR 0.8 (6/36).

Magnification

The average magnification required for near vision was 2.48 X with a range of 1 X to 3 X. Required magnification for near tasks was calculated as:

$$\text{Equivalent viewing power (EVP)} = \frac{\text{Best Corrected Visual Acuity}}{\text{Target Visual Acuity}} \times \frac{100}{\text{Working Distance in cm}}$$

The correlation between the near visual acuity and the magnification requirement is shown in Table No.4

Table No. 4 Correlation between magnification requirement and near visual acuity

Near VA	Magnification Required
Better	1 X
Moderate	1.5 X – 3 X

The distribution of the patients in the study group according to the magnification requirement is depicted below in Table No.5.

Table No. 5 Distribution of the magnification requirement among the study group

Magnification required	No. of Children
1 X	1 (2.8%)
1.5 X	9 (25.7%)
2 X	5 (14.3%)
3 X	20 (57.2%)

With the use of high powered spectacles, reading material has to be kept close to the eye. Higher the power of the lens, shorter is the working distance. So the children were advised to use a reading stand with adjustable tilt to maintain erect posture and prevent neck fatigue.

Seating Distance from Blackboard

The seating distance from blackboard among the children after the use of LVA is shown in Table No.6. The mean distance from the blackboard was 2.6 m, with the standard deviation of 0.65. It was seen that the use of telescope did not affect the seating distance from blackboard as even before the use of LVA, the children were sitting on the first bench (within 2 m of the board) but they had problems in copying text from the board. They always needed help of other children or teachers to understand. Use of telescopes helped to provide a magnified view of text written on the blackboard and helped the child in achieving some independence in understanding and copying material.

Table No.6 Distribution of children according to the seating distance from blackboard

Seating Distance From Blackboard	Number of Children
3 m	18
2 m	12

In 5 children, no improvement in distance visual acuity was noted. Visual acuity for these children was Logmar 2 (Snellen 6/200) and they were unable to read the blackboard at distance of 1 metre. Two of these children were suffering from retinitis pigmentosa, two from buphthalmos and one had microphthalmos with a colobomatous eye. None of them had nystagmus.

Distance At Which Text Held While Using Lva

The mean distance at which text was held while using the LVA was 17.74 mm, with median of 18 and the IQR 5 [Q_1 =15, Q_3= 20]. The distribution of children according to the distance at which text was held while using LVA is shown in Figure 11. Such small distance gives rise to neck and back problems which makes reading a fatiguing task. This causes increase in time period to read the same text as compared to sighted peers, thus, use of an elevated reading stand at an incline with the use of proper lighting source improves reading speed and reduces fatigue. The need to take breaks in between reading also improves the comprehension rate of such children.

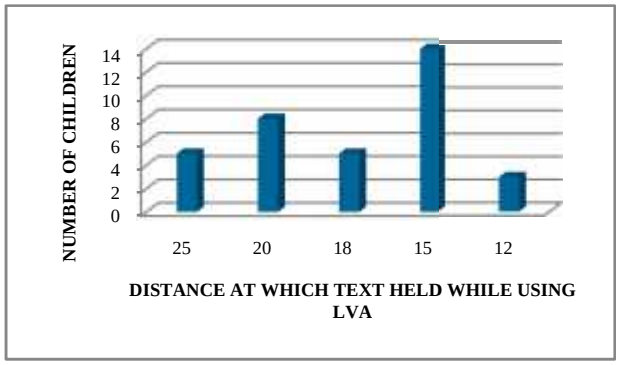

Figure 11 Distribution of children according to the distance of holding text while using LVA

Reading Speed

The mean reading speed of the text before the use of LVA was 11.0 wpm± 3.95. After the use of LVA, mean reading speed increased to 18.7 wpm±5.9. The p-value of 0.004 was significant by Wilcoxon signed rank test and correlation coefficient was 0.95, implying a strong linear relationship between reading speed and use of LVA. The upper and lower limit of 95% confidence interval before and after the use of LVA varied from 12.4, 9.7 to 20.7- 16.7 (post) respectively.

For the ease of analysis, reading ability was classified into four groups based partly on Trauzettel-Klosinski classification. [42]

Fluent reading	>70 wpm
Struggling reading	30-70 wpm
Spot reading	11-30 wpm
No reading	<10 wpm

Unfortunately, none of the children had fluent or struggling reading. Before the use of LVA, 16 (45.7%) children had spot reading and 19 (54.3%) were unable to read. After the prescription of LVA, one gained struggling reading, 30 (85.7%) children gained spot reading, but 4 (11.4%) of them were still unable to read. This child who attained struggling reading was suffering from Heredomacular Degeneration. This is depicted in Table No. 7. They were the same children who did not have improvement in distant visual acuity.

Table No. 7 Improvement in reading ability before and after LVA

Reading ability	Number of children before the use of lva	Number of children after the use of lva
No Reading	19 (54.3%)	4 (11.4%)
Spot Reading	16 (45.7%)	30 (85.7%)
Struggling Reading	0	1 (2.9%)

Comprehension Rate

Comprehension Rate is the ratio of correct responses when using the aid versus not using the aid. The mean comprehension rate before the use of LVA was 46.03±10.4. It changed to 59.45±12.0 after the use of LVA. The correlation coefficient is 0.94, with significant p-value of 0.040 (paired t-test).

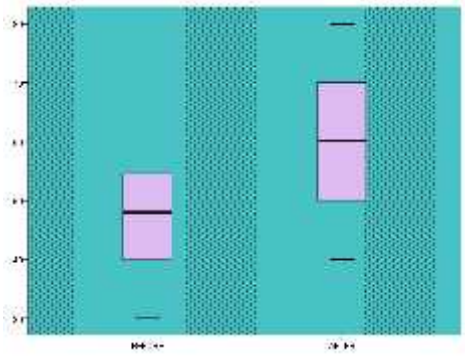

Figure 12 Box Plot showing comprehension rate before and after the use of LVA

Before the provision of LVA, comprehension rate varied from 30 to 60, with a median 48 and IQR of =14. After provision of LVA, range improved to 40 to 80, attaining a median 60 and IQR=20.

Quality of Life Assessment

In this study, patients were assessed using CVAQC containing 17 items. The quality of life is assessed in five aspects: Education, Near Vision, Distance Vision, Getting around, Social Interaction. The distribution of children in various aspects before and after the provision of LVA's according to the total score is shown in Figure 13.

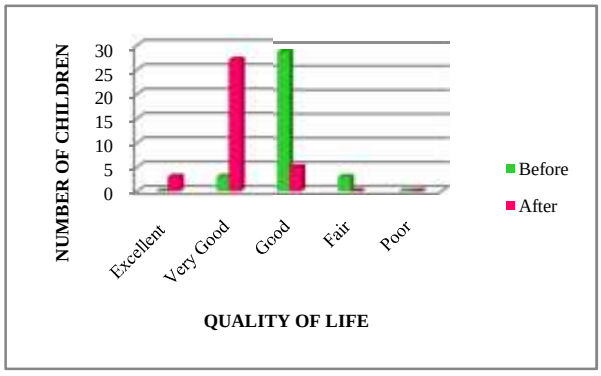

Figure 13 Quality of life score before and after the use of LVA

Before use of LVA's, only 3 (8.6%) had very good quality of life, 29 (82.8%) had good quality of life and 3 (8.6%) had fair quality of life as per the questionnaire. There was a significant improvement in the quality of life (p-value 0.001, paired t-test) after the use of LVA's with 3 children (8.6%) achieving excellent quality of life, 27 (77.2%) very good and 5 (14.2%) good quality of life as per the questionnaire. Before use of LVA, the mean±SD was 62±7.77 (good quality of life) which changed to 42±7.89 (very good quality of life) after use with LVA. The median and IQR range pre and post LVA were 64, 10 and 40, 8 respectively. This demonstrates a shift in quality of life from good to very good.

Achievements

Primary outcome, defined as attaining the near vision of N10 was achieved in 24 (68.6%) children after the provision of LVA.

Secondary outcome defined as

a. Improvement in reading speed: 30 (85.7%) of children could do spot reading after LVA as compared to initial number of 16 (45.7%), thus showing a 40% improvement. One child improved to a struggling reading after use of LVA (2.9%).
b. Improvement in comprehension of written text at distance and near: Comprehension Rate improved significantly in all the subjects with the mean changing from 46.0±10.4 to 59.45±12.0.
c. Improvement in number of lines read: Number of lines improved in near vision in 34 patients who had moderate near VA. In the moderate near vision category 11 cases (32.4%) improved by 1-2 lines and 23 cases (67.6%) improved by 3-4 lines. In better near VA category one improved by 1-2 lines.

The children could read 1-2 hours with the use of LVA. As per the Quality of Life, the maximum benefit perceived by all of them was in reading the textbooks. For distance task of blackboard viewing, although distance from where the blackboard was viewed remained same, all of them agreed that the visibility was better. However, this could not be quantified.

Problems

The children took at least one week to adapt to the new aids. There were often reports of losing their glasses or getting the glasses broken. Only three out of seven actually used the telescopes in classroom. The reason for poor use of telescopes was distrust that their classmates would tamper with them.

Most regular schools have changed the blackboard used for teaching to a green board, but the chalk is still white. This probably caused a poor contrast of white on green board as compared to white on black board. This fact was stated to be one of the main reasons that children did not feel the telescopes magnified their distance reading.

Another problem voiced by the children was poor lighting conditions in the classrooms which were lit by few tube lights. A tube light over the green board was present only in few cases and there was no provision of individual desk/ table lamps to increase the illumination for the disabled children while doing their work. Also the desk tops were not inclined with the slope facing down, as most reading stands do. This led to limited reading on such desks by the low vision children, as fatigue set in within few hours of reading work.

***Non Optical Devices*:** Children were trained to use the reading stand while reading under proper lighting conditions (11 W cold white fluorescent and 60 W incandescent bulb). The use of table lamps with goose neck was also advised. Peaked caps were used in children with albinism to prevent glare while doing outside activities.

DISCUSSION

Our study comprised of 35 children attending the LVA clinic of a referral hospital of Delhi. The mean age ±SD affected in our study was 10.9±3.4, which means we targeted children in primary school level. Males comprised 71.4% in our study. This gender tilt is in concordance with prior studies done by Khan and Khandekar *et al*.[6, 45] This gender skew reflects the male gender bias prevalent in our society where parents are more concerned with ailments of their male progeny and seek remedial measures more often for the male siblings. In addition many inherited disorders being X- linked, are seen more commonly in males e.g. colour blindness, X-linked retinitis pigmentosa. However, no X-linked inheritance pattern was seen in our study.

The affected children in our study mainly belonged to the urban strata. This sampling error was unavoidable as the patient profile attending our outpatient services are primarily from urban background. In addition the emphasis on schooling is more in urban scenario; so these low visionchildren were identified and referred for remedial action. The location of our hospital in the heart of a metropolitan city with children of urban locality having a freer access also contributed to this finding. The major epidemiological study which had identified low vision in India is Andhra Pradesh Eye Disease Study, which did multistage sampling from 24 urban and 70 rural clusters from one urban and three rural areas in different parts of Andhra Pradesh.[4] The data from this study mainly identified rural population as being commonly involved. However, this result cannot be reflected onto our study as APEDS involved subjects of all ages and our study targeted only pediatric low vision.

The major causes of Low Vision identified in our study were Heredomacular Degeneration (17.2%), Optic Atrophy (17.2%), Primary/Secondary Glaucoma (14.3%), Retinitis Pigmentosa (11.4%), Aniridia (8.6%). Retinal diseases were the commonest since these inherited conditions manifest early. This is in concordance with other authors who have reported retinal diseases as the commonest cause. One of the largest community seeking health remedies in our hospital is Muslim community, wherein consanguineous marriages are common. This fact could also account for the high incidence of genetically transmitted retinal diseases in this study. In a study by Gilbert *et al* spanning three continents-Asia, Africa and Latin America; retinal lesions and amblyopia were touted to be commonest causes of functional low vision (FLV).[19]In rural situations with a primarily agragarian background corneal opacities are more common causes, whereas for urban locations retinal lesions are more common.[15] APEDS listed the common causes as retinal diseases, amblyopia, optic atrophy, glaucoma and corneal blindness in decreasing frequency for ALL ages.[4] These results weresimilar in study done by Rishita *et al* which included individuals >15 years of age.[44]

The mean BCVA in our study was 1.3 Logmar (3/60) with range from 0.5 to 2.0 Logmar (6/18 to 6/600). This was poorer vision compared to other studies of low vision with children in Africa where the mean±SD was of 0.122±0.12 and range of 4/60 to 6/24.[8] The lower vision in our children would also have implications in the prognosis and efficacy with LVA use.

The near visual acuities ranged from N6 to N 36 in our study with a mean± SD of 29.14±8.8, prior to LVA use and 10.2±4.3 post LVA. Only few previous studies have reported near

vision. The study by Taha *et al* found near vision from A10 to A 20 (Keeler Series) with mean± SD of 13.6±3.17.[8]

Improvement in near vision occurred in all the children after provision of LVA. After provision of Low Vision Aids (LVA's), 28 of them (80%) attained better VA (N6-N12) and 7 of them (20%) could attain moderate VA (N18-N36). The attainment of primary outcome of success namely reading the print in school books (N10) was achieved by 68.6% of children. These results are in accordance with Taha *et al* study where 86% children could read textbooks after LVA.[8] This proves that majority of low vision afflicted children can be rehabilitated with adequate LVA.

Refractive error predominant in our study was myopia (62.8%) than hypermetropia (37.2%). These results are not compatible with other studies. In study done by G V S murthy *et al* in New Delhi in urban children of 5 to 15 years of age hyperopia showed prevalence of 7.7% as compared to myopia (7.4%).[46] The data from APEDS showed that in subjects <15 years of age prevalence of myopia was 3.19% and hyperopia under cycloplegia was 62.6%.[4]

No significant correlation between contrast sensitivity and reading performance was noted in children of our study. Poor Contrast Senstivity has been documented by Taha *et al* study who reported that contrast sensitivity should not be used in assessment of visual performance in the pediatric age group as contrast sensitivity does not reach adult levels till theage of 7 or 10 years.[8] Children in our study were little older as most were between 8-15 years of age.

The low vision aids most commonly accepted were spectacles. This is due to the fact that children find them easier to work with. A similar observation was made by Taha *et al* and Pal *et al* who concluded that spectacles being a familiar means of visual rehabilitation are more socially acceptable to wearers, peers and parents.[8, 47]

The 25- item Cardiff Visual Ability Questionnaire for Children was found to be a valid and reliable instrument ensuring good content validity, construct validity and temporal stability.[43] It focuses on the most important activities both in and out of the school. The four response categories are a good compromise between stability and response burden. Using this questionnaire a definite improvement in the quality of life occurred after prescription of Low Vision Aids as early as the first week of prescription. This improvement was sustained at the next visit of one month. Since much of the causes of low vision were non-progressive in nature, we assume that the improvement would persist on a long term basis. In fact due to addictiveness of using the LVA and its familiarity, the improvement would enhance.

On analyzing, the tasks which showed improvement after the use of LVA were watching TV, reading blackboard and schoolbooks. Children were able to cope independently in these activities. On the other hand, there was no significant improvement in their outdoor activities like, going out alone in daylight, walking in crowded place, using public transport. These results are similar to that of Taha *et al* study which showed increase in number of children who could watch TV and copy text from blackboard and books. However, use of LVA did not affect outdoor and leisure activities.[8] The study by Rishita *et al*, which used Visual Function Questionnaire (VFQ), showed the most difficult tasks were recognizing small objects, reading small print, recognizing people across the road and recognizing the bus number. Whereas, easy tasks were reaching an object that is farther or closer than you thought, identifying colors, and recognizing people at close distance.[44]

Use of low vision aids seem to help children to attain an independentlife in indoor environmental like schools but not in outdoor environment. It has to be remembered that these children were very young and diffident about daily life activities, so, this data may change as the children grow up using these aids.

Bibliography

1. World Health Organization. The Management of Low Vision in Children. Report of a WHO Consultation: Bangkok, July 1992. Geneva: World Health Organization, 1993. WHO/PBL/93.27.
2. Resnikoff S, Pascolini D, Etya'ale D *et al*. Global data on visual impairment in the year 2002. Bulletin of the World Health Organization 2004; 82: 844-51.
3. Arya SK, Kalia A, Pant K, Sood S. Low vision devices. Nep J Oph 2010; 2(3):74-77.
4. Dandona R, Dandona L. Review of findings of the Andhra Pradesh Eye Disease Study: policy implications for eye-care services. *Indian J Ophthalmol* 2001; 49(4):215-34.
5. National Society for the Prevention of Blindness. Vision Problems in the U.S. New York: NSPB; 1980.
6. Khandekar R, Shah R, Shah M, Harby SA, Vora U, Balushi FA. Ocular status and functional adaptation of visually challenged children of a special school in Oman. Oman Jr Ophthalmol 2011; 4(1):17-20.
7. Cox RFA, Reimer MA, Verezen CA, Switsman ADW, Vervloed MPJ, Boonstra NF. Young children's use of a visual aid: an experimental study of the effectiveness of training. Dev Med Child Neurol 2009; 51:460-7.
8. Labib TA, Sada MAE, Mohamed B, Sabra NM, Aleem HMA. Assessment and Management of children with Visual Impairment. Middle East Afr J Ophthalmol 2009; 16(2):64-8.
9. Resnikoff S, Pascolini D, Mariotti SP, Pokharel GP. Global Magnitude of visual impairment caused by uncorrected refractive errors in 2004. Bull World Health Organ 2008; 86:63-70.
10. Dandona L, Dandona R. Revision of visual impairment definitions in the International Statistical Classification of Diseases. BMC Medicine 2006; 4:7. http://www.biomed central.com/1741-7015/4/7
11. Keefe J. Assessment of low vision in developing countries. Vol.2. Assessment of Functional Vision. Geneva: World Health Organization. WHO/PBL/95,48.
12. Turano KA, Geruschat DR, Stahl JW, Massof RW. Perceived visual ability for independent mobility in persons with retinitis pigmentosa. Invest Ophthalmol Vis Sci. 1999; 40:865-77.
13. Massof RW. A systems model for low vision rehabilitation. I: basic concepts. Optom Vis Sci 1995; 72:725-36.

14. Massof RW. A systems model for low vision rehabilitation. II: measurement of vision disabilities. Optom Vis Sci 1998; 76:349-73.
15. Shah SP, Minto H, Jadoon MZ, Bourne RRA, Dineen B, Gilbert CE, Khan MD, on behalf of the Pakistan National Eye Survey Study Group. Prevalence and Causes of Functional Low Vision and Implications for Services: The Pakistan National Blindness and Visual Impairment Survey. Invest OphthalmolVis Sci 2008; 49(3):887-93.
16. Dandona R, Dandona L, Srinivas M, Giridhar P, Nutheti R, Rao GN. Planning low vision services in India: a population-based perspective. Ophthalmology 2002; 109(10):1871-78.
17. Gilbert C. Blindness in children. BMJ 2003; 327(7418):760-1.
18. Gogate P, Gilbert C, Zin A. Severe Visual Impairment and Blindness in Infants; Cause and Oppurtunities for Control. *Middle East Afr J Ophthalmol* 2011; 18(2):109-14.
19. Gilbert CE, Ellwein LB, and the RESC Study Group. Prevalence and Causes of Functional Low Vision in School-Age Children: Results from Standardized Population Surveys in Asia, Africa, and Latin America. Invest Ophthalmol Vis Sci 2008; 49(3):877-81.
20. Gilbert C, Foster A, Negrel AD, Thylefors B. Childhood Blindness: A new form for recording causes of visual loss in children. Bull World Health Organ 1993; 71:485-9.
21. Birch EE, O'Connor AR. Preterm birth and visual development. Semin Neonatol 2001; 6:487-97.
22. O'Connor AR, Fielder AR, Birch EE. Long term ophthalmic outcome of low birth weight children who did not have retinopathy of prematurity. *Ital J Pediatr* 2002; 28:359-65.
23. Tadesse M, Dhanireddy R, Mittal M, Higgins RD. Race, *Candida* sepsis, and retinopathy of prematurity. Biol Neonate 2002; 81:86-90.
24. Scher MS, Dobson V, Carpenter NA, Guthrie RD. Visual and neurological outcome of infants with periventricular leukomalacia. Dev Med Child Neurol 1989; 31:353-365.
25. Dolk H, Busby A, Armstrong BG, Walls PH. Geographical variation in anophthalmia and microphthalmia in England, 1988-94. BMJ 1998; 317(7163):905-9.
26. Curtin BJ. Myopia: A review of its etiology, pathogenesis and treatment. Surv Ophthalmol 1970; 15:1-17.
27. Mutti DO, Mitchell GL, Moeschberger ML, Jones LA, Zadnik K. Parental Myopia, Near Work, School Achievement, and Children's Refractive Error. IOVS 2002; 43(12):3633-40.
28. Angle J, Wissmann DA. The epidemiology of myopia. Am J Epidemiol 1980; 111:220-28.
29. Hung GK, Ciuffreda KJ. The effect of nearwork on transient and permanent myopia [ARVO Abstract]. Invest Ophthalmol Vis Sci 2001; 42(4):S392 Abstract nr 2117.
30. Golomb MR, Walsh LE, Carvalho KS, Christensen CK, DeMyer WE. Clinical findings in Pelizaeus-Merzbacher disease. *J Child Neurol* 2004; 19(5):328-31.
31. Schmutzhard J, Schwentner I, Gluekert R, Sergi C. Pelizaeus-Merzbacher disease: Morphological analysis of the vestibule-cochlear system. Acta Otolaryngol 2009; 129(12):1395-9.
32. Hoyt CS, Bilson FA. Optic Nerve Hypoplasia: Changing Perspective. Aust New Zealand J Ophthalmol 1986; 14:325-31.
33. Shastry BS. Persistent hyperplastic primary vitreous: Congenital malformation of the eye. Clin Exp Ophthalmol 2009; 37:884-90.
34. McColm JR, Fleck BW. Retinopathy of Prematurity: Causation. Semin Neonatol 2001; 6:453-60.
35. Shields JA, Shields CL. Intraocular tumors – A text and Atlas. Philadel phia, PA, USA: WB Saunders Company; 1992.
36. Basic and Clinical Sciences Course. Pediatric Ophthalmology and Strabismus. American Academy of Ophthalmology 2002; 360-6.
37. Dale N, Salt A. Early support developmental journal for children with visual impairment: The case for a new developmental framework for early intervention. Child Care Health Dev 2007; 33:684-90.
38. Day S. Normal and abnormal visual development. In: David T, editor. Pediatric Ophthalmology. Oxford UK: Blackwell Science; 1997.p.13-28.
39. Hyvarinen L. Assessment of low vision for educational purposes and early intervention, Part 1, Precision Vision: La Salle; 1999.p28.
40. Azad YA. Integration of disabled in common schools: A survey-study of IEDC in the country. New Delhi: National Council of Educational Research and Training; 1996.
41. Pearce E, Crossland MD, Rubin GS. The efficacy of low vision device training in a hospital-based low vision clinic. *Br J Ophthalmol* 2011; 95:105-8.
42. Trauzettel-Klosinski S, Dieling CH & Pietsch B: The influence of visual field defects and other clinical parameters on reading performance: A retrospective study in a low vision population. Visual Impairment Research 2003; 5:83-100.
43. Khadka J, Ryan B, Margarin TH, Court H, Woodhouse JM. Development of the 25- item Cardiff Visual Ability Questionnaire for Children (CVAQC). *Br J Ophthalmol* 2010; 94:730-5.
44. Nutheti R, Shamanna BR, Krishnaiah S, Gothwal VK, Thomas R, Rao GN. Perceived Visual Ability for Functional Vision Performance among Persons with Low Vision in the Indian State of Andhra Pradesh. Invest Ophthalmol Vis Sci 2004; 45(10):3458-65.
45. Khan SA. A Retrospective Study of Low-vision Cases in an Indian Tertiary Eye-care Hospoital. *Indian J Ophthalmol* 2000; 48:201-7.
46. Murthy GVS, Gupta SK, Ellwein LB, Munoz SR, Pokharel GP, Sanga L, Bachani D. Refractive Error in Children in an Urban Population in New Delhi. Invest Ophthalmol Vis Sci 2002; 43(3):623-31.
47. Pal N, Titiyal JS, Tandon R, Vajpayee RB, Gupta S, Murthy G. Need for optical and low vision services for children in schools for the blind in North India. *Indian J Ophthalmol* 2006; 54:189-93.

****