

# Pediatric Low Vision Management

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## Abstract

Vision is responsible for 80 -90% of what the child learns during first 6 years of life and promotes growth and development. Specific expertise and methodology is required to evaluate and manage children with low vision. Pediatric low vision care is no longer limited to magnifiers, large print books or white cane. Through this review on low vision in pediatric population, early intervention, functional vision, use of available diagnostic and types of low vision devices are highlighted. A multidisciplinary, holistic approach and coordinated effort will make children with low vision maximize the residual vision for educational, recreational, social, developmental and quality of life.

**Keywords:** functional vision, Pediatric low vision assessment, low vision devices

There are about 400 million children in India. Population-based studies reflect the prevalence of blindness in children in India is 0.75/1000. Prevalence of blindness varies from 0.3/1000 in well-developed states to 1.5/1000 in the poorest states out of which 680,000 may be blind, including 226,440 with easily treatable refractive error.<sup>1,2</sup>

The WHO working /functional definition of Low Vision is defined as “a person with low vision, who has impairment of visual functioning even after treatment, and/or standard refractive correction, and has a visual acuity of less than 6/18 to light perception or a visual field of less than 10 degrees from the point of fixation, but who uses, or is potentially able to use, vision for the planning and/or execution of a task.”<sup>3</sup> The use of the functional definition ensures that children who have vision less than 3/60 are included for the low vision services to help them to utilize their useful residual vision to its maximum potential. Population-based studies have shown the prevalence of low vision to be 1.05% in India.<sup>4</sup> Majority of these visually impaired children are sent to blind schools.

## Causes of Low Vision

To holistically treat the child with low vision, an understanding of pathology is necessary. The main causes as per structure involved are described in (Table 1).<sup>5-7</sup>

**Table 1: Eye Conditions Causing Low Vision Based On the Structure Involved**

Structure involved	Eye Diseases
Cornea	Corneal opacities, Dystrophy, Keratoconus, Microcornea
Lens	Uncorrected Aphakia / Pseudophakia with Amblyopia
Uvea	Aniridia, Choroidal degeneration, Coloboma of iris or choroid.
Vitreous	Persistent Primary Hyperplastic Vitreous (PHPV)
Retina	Heredomacular dystrophy, Stargardts Diseases , Retinitis pigmentosa, Retinal scars, Retinopathy of prematurity (ROP), Rod-cone dystrophies
Optic nerve disorders	Optic neuropathy, Optic atrophy
Globe abnormalities	Microphthalmos, Coloboma, Degeneration due to uncorrected/high refractive errors and Amblyopia
Visual Pathway	Cortical visual Impairment, Delayed visual Maturation
Others	Primary Nystagmus, Glaucoma, Albinism, Neurological disorders & Tumors, Trauma

## Paediatric Low Vision Assessment

The impact of visual impairment at an early age can impair motor, cognitive and sensory acquisitions and increase the risk of intellectual and emotional difficulties thus impair the self-esteem and social integration.<sup>8-11</sup>

### A. Information and History

- Background data: The information can be gathered from primary caregivers on use of vision, sensory stimuli and communication.
- Patient history and observation: Current educational / vocational status and daily living skills, observations on visual and sensory functioning can give a clue on how the individual is using his vision.
- General medical history: Seizures, drug intake (All this should be kept in mind during testing procedures

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requiring vestibular stimulation, strenuous physical activity and administration of ocular drugs)

- Behavioural Observations: Look for assaultive, aggressive, self-abuse, tactual defensiveness, hyperactivity, fearfulness, squinting, light gazing, eye poking, head tilting or turning, mobility and movement postures, etc.
- Visual behaviour: Look for eye contact, and note at the distance within which communication can be made. An alert child repeatedly changes the direction of gaze to fixate on different targets. The child with impaired vision appears to look past the examiner with inaccurate and less frequent eye movements.
- Eye movement: check for nystagmus (particularly with additional optic nerve hypoplasia), gaze palsies, oculomotor apraxia. (Impaired tracking may cause children to have no interest in fast moving cartoons but to prefer TV programmes with limited movement)

### B. Clinical low vision examination (Table 2)

The optimal tools required to complete the test depends on individual cognitive and visual skills, aetiology and prognosis of the visual dysfunction, accompanying visual conditions such as nystagmus or photophobia. Ocular health examination should always be done in individuals preferred position with positive reinforcement. More than one session may be required. All the tests might not be required or might not be possible to perform in one assessment setting

- I. Visual acuity: One single test is not sufficient to determine visual acuity levels. One should combine the results of the observations of the different tests and individual behaviour to yield more valuable results. Tests must be appropriate for age and ability.
  - a. Detection acuity (Catford drum or STYCAR balls): Estimates the minimum size visible. It is tested in individuals who cannot perform two dimensional symbols or gratings. It provides the parents and teachers information about the size and contrast of solid objects which will help in eye hand coordination and sorting activities.
  - b. Resolution acuity (preferential looking cards, Cardiff acuity cards, Tellers acuity cards, LEA Gratings cards) . It is the minimum separation which allows discrimination. It is useful in individuals with cortical visual impairment, delayed visual maturation, developmental disabilities and optic nerve involvement. It is insensitive in cases of strabismic amblyopia and macular abnormalities.
  - c. Recognition acuity (LEA symbol, HOTV, broken wheel visual acuity cards, letters or pictures): The logmar system of distance acuity is used as it allows for consistent and accurate evaluation of visual acuity levels. It can be done by matching, naming, and pointing. It should be done binocularly first then unocularly. Repeated testing will be required for more positive response. The near acuity is tested in M notation at 40 cms and the smallest print read at comfortable reading distance. This provides the threshold near acuity levels and helps in magnification calculation for reading.<sup>10,11</sup>
- II. Electro-diagnostic testing: Electroretinogram (ERG) measures the electrical activity in the patient's retina. It is valuable test in cases of retinal dystrophies where it may be decreased before the ophthalmological changes are distinct. Visual evoked potential (VEP) is a measure of the electrical activity at the visual cortex. It yields visual acuity estimates and is a measure of macular functioning. It cannot monitor cognitive functioning. Children with poor visual response, substantially normal afferent visual system and favourable electrodiagnostic testing may be helped by visual stimulation.
- III. Light and Form response: Blink response, pupillary constriction, avoidance response in direct light and near stimulation, indicates a positive response of visual discrimination. Flicker bulb preferable red can be used to elicit the response. However absence of pupillary response does not rule out the absence of visual response.
- IV. Refractive Error: Associated in conditions like albinism, Downs syndrome, ROP, rubella, cerebral palsy, microphthalmos, monochromatism, etc. Always perform a cycloplegic refraction in individuals with unsteady fixation, fluctuating reflex, hyperopia and squint. An appropriate distance target suitable for an individual is desirable to maintain fixation and minimize accommodation. In case where cycloplegic refraction is not possible then one can perform near retinoscopy or dynamic retinoscopy. Specialized techniques like bracketing and over refraction are commonly used. The refraction is performed both objectively and subjectively. Always prescribe glasses whenever significant refractive error is present. (>1D sphere, >1.5D cylinder)
- V. Ocular alignment and binocularity: Hirschberg test is done to check for motor alignment. Bruckner's test is an observation of brightness difference in between the fundus reflex. It is a screening test for squint/ amblyopia detection. Sensory alignment determines amblyopia, suppression, diplopia, stereopsis, etc. Other observations to determine eye dominance are difference in visual acuity, refractive errors, head posture, visual fields.
- VI. Ocular motility: Check for ocular tracking, saccades, pursuit skills.
- VII. Accommodation and convergence (One can use simple push-up or pull out amplitude). Some children with brain damage (cerebral palsy) have reduced or absent accommodation and therefore poor three dimensional tracking. It can also lead to difficulties in working or learning with small detailed targets at near working distance. Retinoscopy prior to cycloplegia can identify

**Table 2: Clinical vision Assessment at a glance**

<i>Activity</i>	<i>How to do</i>	<i>Importance</i>
Observation	The child should be observed as soon as he enters the room	Help us to know how the child is using his vision functionally
History	Visual history, birth history, Medical history, developmental history school history, use of spectacles	It helps to understand the emotional status and individual needs of the child.
Visual Function	Test /Equipment	
Vision assessment	Preverbal Children: Resolution acuity by Teller acuity, Optokinetic nystagmus drum, VEP , Cardiff acuity charts , Lea's preferential looking paddles  Verbal Children: Recognition Acuity: (Distance and near): Snellen's, ETDRS, LogMar, Sloan's Letters, Lea's symbols, HOTV.  Universal and pediatric trial frames, long handled occluders, Halberg clips, pointer, trial lens holder, clip-on pin-hole, Jackson's cylinders up to 2 diopters, ruler and torch, full aperture trial lens set.	<ul style="list-style-type: none"> <li>• Monitor the effect of, stability and progression of a disease</li> <li>• To assess pupillary reaction, eccentric viewing postures and skills, patient motivation, scanning ability</li> <li>• Teach basic concepts and skills (i.e., to eccentrically view) relevant to the rehabilitation process.</li> <li>• Determining initial magnification requirements.</li> <li>• Estimate the dioptric power of optical aids necessary for reading regular print size</li> <li>• Classify patients as "legally blind" for the purposes of government, insurance and other benefits of exemptions</li> </ul>
Refraction	Streak retinoscopy, Cycloplegic refraction	To know the need of spectacles type and power of low vision devices.
Visual field testing	Quantitative analysis -Confrontation test Qualitative analysis - Amsler's chart (identify subtle visual scotomas or metamorphopsia from macular disease and optic nerve)	Orientation Mobility , type and power of device, vision training
Color vision testing	Farnsworth 100 Hue, HRR plates, Ishihara plates, Colour matching games , Colour naming	Educational , Vision training and career counselling
Contrast sensitivity testing	Hiding Heidi test ,Mr. Happy face , Lea contrast flip chart, Pelli Robson test, Vistech contrast testing	Educational need , Type and power of low vision device, Illumination and size of the print required , Orientation and mobility training
Stereopsis	Titmus fly test, Lang test, Synaptophore	Power and type of device
Eye hand co-ordination	Puzzles, Toys	Vision training, use of device
Glare testing	Caps, Umbrella , Absorptive lenses, tinted spectacles, photochromic lenses ,tinted contact lenses	Illumination level and orientation and mobility training

impaired accommodation and reveal manifest hypermetropia not corrected by the accommodative reflex. The provision of spectacles can give gratifying results.

VIII. Visual Fields (confrontation test): Functional visual field assessment is carried out binocularly, particularly to elicit homonymous defects. Best is to do with the practitioner and the assistant. For the young child, the attention is attracted while a toy target that is introduced from behind in each of the four quadrants, anticipating a head turn. See for any eccentric fixation. For the older,

co-operative child small discreet movements of an extended forefinger in each of the four quadrants, both singly and on both sides simultaneously, can be made into a game. Check for midline problems.

IX. Contrast sensitivity (Mr Happy contrast sensitivity test, Hiding Heidi contrast test chart). It helps to know individuals functional visual capabilities, choosing educational materials. Reduced contrast sensitivity necessitates the use of high contrast educational material and higher magnification.

- X. Colour vision: (Assorted toys of different colours) can be performed by Colour naming, colour identification, colour preference, or colour vision defects detection test. Helps in identifying appropriate educational material, self-help and work related goals required by an individual.
- XI. Photosensitivity: Usually found in individuals with congenital ocular disorders such as albinism, rod monochromatism, congenital cataracts, aniridia and individuals on anti-convulsion medication.

### C. Functional vision assessment

Functional Vision refers to an individual's ability to use his/her vision in the everyday tasks of real life, such as reading, playing, getting around in environment. It helps to know how well a child uses his/her vision to perform routine tasks in different places and with different materials throughout the day. This information gathered helps to develop an educational programme of individual child. The following are components which should be addressed in a functional visual assessment.<sup>14,15</sup>

- Visual Efficiency and Potential (Table 3)
- Recognition of Objects
- Distance Requirements
- Size Requirements
- Lighting Requirements
- Color Perception
- Visual Discrimination
- Contrast Sensitivity
- Exploration of Objects Visual, Tactual, Mouthing, Auditory
- Check for cognitive development
- Any components which were contradictory or omitted from the optometric or ophthalmological report which may be assessed functionally

### D. Management of Paediatric low vision

**Table 3: Functional visual skills (WHO Low Vision Kit)**

1. Awareness and attention to objects (Fixation)
2. Control of eye movements (Tracking)
3. Control of eye movements (Scanning)
4. Discrimination of objects
5. Discrimination of details to identify actions and match objects.
6. Discrimination of details in picture.
7. Identification and perception of patterns, numbers and words

Once the assessment is done and information gathered and analysed, it is important to develop appropriate individual management plan.

### Medical

- Appropriate refractive correction.
- Surgical intervention whenever required
- Appropriate glare control glasses.
- Prescription and training to use a low vision device
- Binocular vision therapy.

- Patching therapy in cases of amblyopia
- Appropriate referral for other disability
- Prognosis for improvement should be explained to the individual.

### Functional

The individual should be encouraged to relate visually to his/her environment. Appropriate visual stimulation programme should be planned and explained to the individual.

- Emphasis on size, colour, contrast, distance and illumination of targets
- Choose toys /games keeping in mind the developmental levels.
- Eye tracking exercise
- Peripheral awareness therapy
- Searching and scanning strategies
- Central or eccentric viewing strategies
- Visual reach activities.
- Office based vision stimulation therapy
- Support from special educators.
- Orientation and mobility instruction

### Educational

Results of evaluation should be written or discussed with the parent/teacher/special educator. Following information will be useful in education planning of a child

- Levels of lightening and sensitivity to glare
- Positioning of the individual
- Size of material
- Placement of material in optimal visual field
- Appropriate colors
- Brightness
- Need for clutter reduction
- Spacing of visual information
- Orientation and mobility in the environment

### E. Low Vision Devices

Low vision device is an aid that enables a person with low vision to improve visual performance and to avoid visual disability.<sup>16-18</sup> They are categorized as optical, non – optical and electronic magnification system (Table 4).

Reading speed in words per minute (wpm), fluency and comprehensiveness are required to decide the choice of reading medium.<sup>19</sup> Print /Braille/ print + Braille is decided depending on the reading speed and the nature of the diseases (progressive versus non progressive).

### Pre requisites before prescribing devices for distance

- Correct patients refractive error (with spectacle or contact lens)
- Verify the power of the device
- Check for appropriate illumination
- Instruction in the use of device, which includes-localization, focusing, spotting, tracing, tracking, and scanning

### F. Magnification calculation

**Table 4: Types of Low Vision Devices**

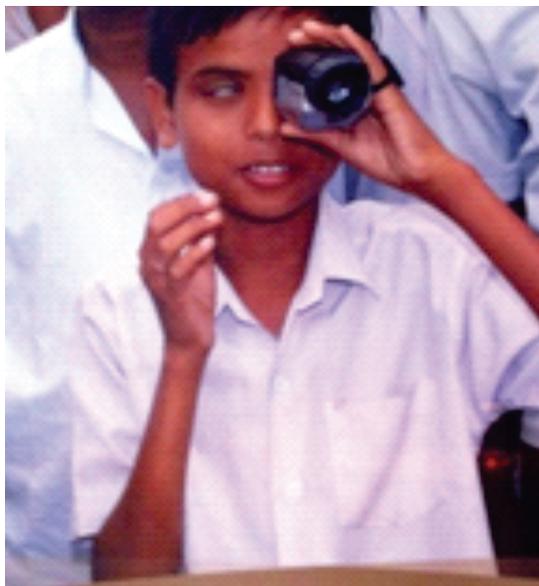
Distance Optical Devices	Telescopes, Optima TV Viewing Glasses, Bioptics etc (Figure 1,2)
Near Optical Devices	Prismatic Spectacle Magnifiers, High Adds lenses, Telemicroscopes, Hand magnifiers, Stand Magnifiers (Figure 3, 4, 5)
Electronic magnification devices	Closed circuit television, Hand held CCTV Magnifiers, adaptive computer software (Figure 6, 7)
Peripheral Vision enhancement	Scanning exercise, Visual field expanders
Contrast enhancing device	Typoscopes, Reading lamp, Signature guide, Bold line books, Reading guide/writing guide, felt tipped pens, Large print material (Figure 8)
Glare control devices	Absorptive lenses for glare, Tint, lens coatings, Caps, Visors, (Figure 9)
Postural Correction devices	Writing aids/reading stand,
Others	Vision stimulation charts and lights, vocal synthesisers etc



**Figure 2:** TV Viewing Magnifier used for watching television from 2 meter distance



**Figure 3:** Prismatic Spectacle Magnifier for reading any text for longer duration



**Figure 1:** Child using Telescope for distance viewing (Black Board)



**Figure 4:** Stand Magnifier used for near reading in eccentric fixation



Figure 5: Hand Magnifier for spot reading/viewing for near vision



Figure 6: Electronic CCTV Mouse Camera attached to TV/Computer when patients require higher magnification and good contrast



Figure 7: Electronic Hand Held Video magnifier used when patients require higher magnification and good contrast

The main aim of these low vision devices is to produce a system which enlarges the retinal image (RIM). It is based on the principle of relative magnification system. Retinal image magnification (RIM) is a product of three factors – (relative size magnification) x (relative distance magnification) x (lens vertex magnification)<sup>20</sup>

a) Principles of magnification at distance point<sup>21</sup>  
Magnification is calculated by the formula  
 $M(t) = BVA/TA$

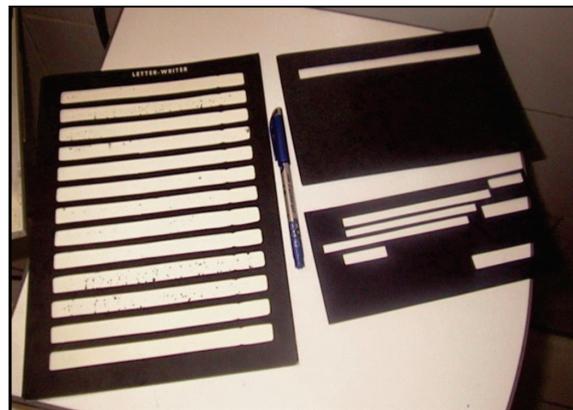


Figure 8: Writing and reading Guide is used to enhance the contrast and eccentric fixation



Figure 9: Filters/glare control glasses used in albinism, cone dystrophies, etc

BVA =Best Visual Acuity, TA= Targeted Acuity  
e.g. distance vision =6/60 and Goal distance acuity= 6/15  
(as this acuity is required for reading street signs, bus number and watching television so  $60/15 = 4x$  (power of telescope) So start your trail of telescope from 3x, keeping in mind the power ,size and contrast as more is the power of telescope lesser will be the field of vision, brightness and contrast.

b) Principles of magnification at near point<sup>21</sup>

1. Relative distance magnification: Moving the object closer to the eye (shortening the distance) causing a proportional enlargement of the retinal image. eg. Sitting in front of the television, holding a book close while reading (most children can easily do this) etc.
2. Relative size magnification: Enlarging the physical size of an object, such as large print rather than standard print. eg. Large print books, writing large letters.
3. Angular magnification: Using an optical system such as telescopes, magnifiers.
4. Electronic magnification: Enlargement of an object is achieved by projecting the object onto the screen such as films, slides. eg. CCTV

### Conclusion

Early intervention and rehabilitation in paediatric population with low vision is a key to successful acceptance of low vision management and thus help them in education, social and recreational integration

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