• Brief Report •

Functional outcome of the low vision aids for visual impairment secondary to central nervous system tumors in children

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Abstract

• To assess functional outcomes of optical low vision aids (LVAs) for pediatric visual impairment due to central nervous system (CNS) tumors. A prospective case study was conducted on 15 children with history of CNS tumors with mean age of 10.47±1.85y. Lighthouse distance, near visual acuity tests, cycloplegic refraction, reading speed measurement and visual field examination were done. Prescription of far and near LVAs followed by training sessions. LVPrasad-functional vision questionnaire was done to evaluate performance. Visual impairment was moderate (13.3%), severe (73.3%), profound (6.7%) and near blindness in 6.7%. Telescopes prescribed in 33.4%, video magnifier in 46.7%. Questionnaire scores were significantly improved for distant rather than near tasks ($P \leq 0.05$) after training. LVAs rehabilitation is an effective method of improving vision in pediatric visual defects secondary to CNS tumors.

• **KEYWORDS:** visual impairment; low vision aids; central nervous system tumors

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INTRODUCTION

Pediatric visual impairment is a need territory for vision 2020. Visual hindrance in youth can influence their psychological, physical, passionate and neurological development[1-2]. Low vision is defined as visual acuity of less than 6/18 but equivalent to or superior than 3/60, or a corresponding visual field loss less than 20 degrees, in the better eye with the best possible correction[3]. Early evaluation with provision and training of low vision aids (LVAs) is fundamental to enhance practical vision so enabling most kids to enroll in mainstream schools[4-5].

Central nervous system (CNS) tumors are the most frequent solid tumors in children and adolescents[6]. Visual impairment associated with pediatric CNS depends on the area, tumor type, and duration of the disease. Gothwal *et al*[7] built up a questionnaire to survey the self-reported functional capacities of visually impaired children: the LV Prasad-functional vision questionnaire (LVP-FVQ).

The main goal of the present study was to assess the functional outcome of the use of optical far and near LVAs for pediatric low vision with CNS tumors related visual impairment and their impact on educational abilities.

SUBJECTS AND METHODS

Ethical Approval This study was completed in agreement to the fundamentals of the Declaration of Helsinki and performed according to the recommendations of Faculty of Medicine, Ain Shams University Research Ethical Committee (FMASU REC; No. FWA000017585). Nature of the study were disclosed to the guardians in detail and an informed consent was taken.

A prospective case study was conducted on 15 children with history of CNS tumors with visual impairment. They had completed their therapy two years before seeking visual rehabilitation with stable medical condition. They were referred to the pediatric low-vision clinic to evaluate visual performance according to World Health Organization classification of visual impairment and for visual rehabilitation[3]. Children less than 6 years old, those with different disabilities as intellectual impairment, hearing defects and those who utilized optical LVAs previously were barred from the study.

Full ophthalmic history, detailed ophthalmic examination, unaided far and near visual acuity (line acuity), refraction followed by best corrected visual acuity (BCVA) were done. Distance visual acuity was measured using Lighthouse Distance Visual Acuity Landolt Ring test. Near visual assessment was done using the Lighthouse near acuity test (THE LIGHTHOUSE Low Vision Products, 36-02 Northern BLVD; Long Island City, NY, USA).

Visual field assessment was carried out by Goldmann kinetic and static perimetry, using large stimulus (V4-white target) projected on a 31.8 apostilb (asb) [10 candelas per square meter (cd/m^2)] white background for cooperative children using Oculus Twinfield 2 Analyzer (Oculus Optikgeräte GmbH, Wetzlar-Dutenhofen city, Germany). Reading speed was assessed by continuous text and measured by numbers of words read per minute (wpm) by this simple formula: wpm=(number of pages read×number of words per average page) divided by the number of minutes spent reading.

For calculation of magnification, the required magnification (M) for distance=desired visual acuity/actual visual acuity. As the higher magnification the narrower the field of view, thus the least effective magnification suitable was prescribed to avoid field restriction. Starting magnification needed for near vision was calculated from the lighthouse near acuity test chart used for near vision assessment. This addition power was then refined and adjusted to be adequate for the child's needs by requesting the patient to read a continuous content (school books). In the wake of picking the proper perusing reading aid, the child's reading speed was measured to assess the improvement and to be utilized as a baseline value to survey the improvement.

For far distance viewing, handheld telescopes and telescopic systems mounted in glasses were used. Reading aids include high plus glasses, telescopic systems for near mounted in glasses, clip on lens magnifiers over glasses, stand magnifiers and electronic magnifiers as video magnifier pocket viewer.

All children gotten in-office instructional sessions to acquaint them with the utilizations and restrictions of the optical aids recommended until the child showed satisfactory expertise. Training for reading involved; appropriate handling of the aids, optimizing eye movements and figuring out how to utilize the ideal retinal locus. The main policy of training for distance vision aids consist of five main items: spotting, focusing, tracing, tracking, scanning. The previously validated questionnaire (LVP-FVQ) was translated into Arabic and administered to the child at the first principle visit and at 3mo after low vision rehabilitation.

The patients were examined 3mo after training for BCVA for near and far using LVAs and visual function was assessed by practitioner observations and assessment questionnaire.

Statistical Analysis All data were coded and statistically analyzed using the SPSS (Social package for statistical science) version 13.0 for windows (SPSS Inc., South Wacker Drive, Chicago, USA). Quantitative variables were expressed as mean and standard deviation (SD). Qualitative variables were described in the form of numbers and percentages. Paired student's *t*-test was utilized to compare quantitative data. Chi-square test was utilized to compare qualitative data. $P \leq 0.05$ was considered as statistically significant.

RESULTS

Study included 15 children with mean age of 10.47±1.85y (range 7.0-14.0y), 11 males (73.3%) and 4 females (26.7%). CNS tumors of those children were craniopharyngioma (46.7%), optic nerve glioma (26.7%), ependymoma (6.7%), posterior fossa astrocytoma (6.7%), pituitary tumor (6.7%) and leukemic cerebral infiltrates (6.7%). All the patients had completed their tumor therapy two years before seeking visual rehabilitation .

Visual impairment was classified according to BCVA of the better seeing eye prior to use of far LVAs into: moderate visual impairment in two patient (13.3%), severe visual impairment in 11 patients (73.3%), profound in one patient (6.7%) and near blindness in one patient (6.7%).

Prior to the use of LVAs, distance visual acuities (logMAR) ranged from 0.0 to 2.2, mean distance visual acuity was 1.27±0.31, near visual acuities (logMAR) ranged from 0.6 to 1.6, mean near acuity 1.25±0.33. Visual acuity of the better seeing eye was equal to or less than 1.3 logMAR in (60%) of patients.

Far vision aids were prescribed according to the visual acuity and tasks of each patient. Far visual acuities (logMAR) after LVAs ranged from 0.2 to 1.22; mean distance visual acuity was 0.65±0.37. Children who received distance LVAs achieved aided distance visual acuity of 0.7 in four patients (26.7%), 0.3 in three patients (20.0%), one patient for each (6.7%) achieved aided distance visual acuity of 0.2, 0.22, 0.4, 0.5, 0.92, 1.0, 1.1, and 1.22 respectively with an average number of lines gained by the patients to be 6.26±2.84 (range: 1.0-11.0).

Spectacle-mounted Galilean telescopes were the most frequently used distance LVA. Binocular telescopes were prescribed for seven patients (46.7%) and monocular telescopes were prescribed for eight patients (53.3%).

BCVA in the better eye after use of far LVAs was markedly improved in all patients and classified into: near normal vision in four patients (26.7%), moderate in eight patients (53.3%) and severe in three patients (20%). There was a statistically significant improvement in degree of visual impairment following the use of far LVAs (P=0.019). Table 1 demonstrated the types and effects of use of LVAs on far vision correction.

Near vision aids prescription were: binocular high plus near reading addition glasses in four patients (26.7%), stand magnifiers in three patients (20.0%), video magnifiers in seven patients (46.7%). Binocular glass mounted telescope for near was prescribed for one patient (6.7%).

Marked improvement in near vision noticed in all patients. The near visual acuities (logMAR) after near LVAs were ranged from 0.1 to 0.8; the mean near visual acuity was 0.23±0.24. The impact of near vision aids on the near visual acuity was as per the following: 11 patients (73.3%) achieved aided near

Table 1 Types and specifications of LVAs used for far vision, and the BCVA before and after their use

Patient No.	Far VA at initial visit (logMAR)		Use of LVAs for far	Magnification (diopters)		Far BCVA after use of LVA (logMAR)	
	OD	OS		OD	OS	OD	OS
1	1.3	1.3	Binocular	Telemed 3×; working distance 70 cm to infinity; visual field 160 m/1.0 m	Telemed 3×; working distance 70 cm to infinity visual field 160 m/1.0 m	0.7	0.7
2	0.92	2.5	Monocular	4× telescope Working distance 200 m	-	0.3	-
3	1.3	2.4	Monocular	2.5×; working distance infinity; visual field 250 m/1.0 m (wider field)	-	0.7	1.3
4	0.0	No PL	Monocular	6×; visual field 175 m/1.0 m (10°)	-	0.7	-
5	1.3	1.0	Binocular	Telemed 4×; working distance 78 cm to infinity; visual field 130 m/1.0 m	Telemed 4×; working distance 78 cm to infinity; visual field 130 m/1.0 m	0.4	0.3
6	2.2	2.5	Monocular	6×; visual field 175 m/1.0 m (10°)	-	1.3	-
7	1.3	1.3	Binocular	4× telescope; working distance 200 m	4× telescope; working distance 200 m	0.2	0.2
8	1.3	2.4	Monocular	6×; visual field 175 m/1.0 m (10°)	-	0.4	-
9	1.3	1.6	Binocular	Telemed 3×; working distance 70 cm to infinity; visual field 160 m/1.0 m	Telemed 3×; working distance 70 cm to infinity; visual field 160 m/1.0 m	0.22	1.22
10	1.3	1.3	Binocular	Telemed 4×; working distance 78 cm to infinity; visual field 130 m/1.0 m	Telemed 4×; working distance 78 cm to infinity; visual field 130 m/1.0 m	1.0	1.0
11	1.0	1.0	Binocular	Telemed 4×; working distance 78 cm to infinity; visual field 130 m/1.0 m	Telemed 4×; working distance 78 cm to infinity; visual field 130 m/1.0 m	0.3	0.4
12	1.3	1.1	Binocular	Telemed 4×; working distance 78 cm to infinity; visual field 130 m/1.0 m	Telemed 4×; working distance 78 cm to infinity; visual field 130 m/1.0 m	1.1	0.5
13	1.6	2.5	Monocular	2.5×; working distance infinity; visual field 250 m/1.0 m (wider field)	-	1.22	-
14	No PL	1.3	Monocular	-	6×; visual field 175 m/1.0 m (10°)	-	1.1
15	1.3	1.22	Binocular	Telemed 4×; working distance 78 cm to infinity; visual field 130 m/1.0 m	Telemed 4×; working distance 78 cm to infinity; visual field 130 m/1.0 m	0.92	1.0

OD: Right eye; OS: Left eye; VA: Visual acuity; BCVA: Best corrected visual acuity; logMAR: Logarithm of minimum angle of resolution; PL: Perception of light.

visual acuity of 0.1, one patient each (6.7%) accomplished aided near visual acuity of 0.4, 0.5, 0.8 and 0.7 respectively. The average number of lines gained by the patients was 10.26±2.68 (range: 5.0-15.0; Table 2). Following the use of LVAs, visual acuity of the better eye was equal to or better than 0.3 logMAR was achieved in 40% of patients for far vision and 73.3 % of patients for near vision (Table 2).

Reading speed before using the near visual aids was <20 wpm in three patients (20%), 20-40 wpm in three patients (20%), nine patients cannot read at all without LVA (60%). With using of near visual aids reading speed improved in all patients showing reading 20-40 wpm in one patient (6.7%), 40-60 wpm in nine patients (60%) and >60 wpm in five patients (33.3%). Table 2 demonstrated the types and effects of use of LVAs on near vision enhancement.

A statistically significant improvement was found in far and near visual acuities after low vision aids prescription compared to visual acuities at presentation (P<0.01). Concentric contraction of the peripheral field up to 20 degrees with no involvement of the central field was detected in 6 patients (40%) and one patient (6.7%) had complete homonymous hemianopia. It was difficult to perform it in the rest of the patients because of poor vision and uncooperative children.

The response to the LVPrasad-FVQ pre- and post-LVAs was summarized in Table 3. The most frequently affected visual tasks were those related to near vision and hence affect their education. As a response to question number 20; preceding the utilization of the aids, 73.3% of children expressed that their vision was much worse than their companions' vision; the rest expressed that it was a little worse than their companions. After use of aids, 53.3% expressed that their vision as good as their companions and 46.7% expressed that it was a little worse than their companions. The variance in functional vision pre- and post-LVAs was statistically significant with all activities (P<0.05).

DISCUSSION

Low vision patients' prevalence is expanding as future increments. In Egypt, visual impairment accounts for 7% of all types of disabilities[8]. Mousa *et al*[9] reported that the incidence of best seeing eye presenting with moderate visual impairment, severe visual impairment, and blindness to be 23.9%, 6.4%, and 9.3% respectively.

In our study, visual acuity improvement in children with low vision following the use of LVAs was documented in all

Table 2 Types and specifications of LVAs used for near vision, the BCVA and the reading speed before and after their use

Patient No.	Near BCVA before use of LVAs		Reading speed before use of LVAs	Use of LVAs for near	Magnification (diopter)		Near BCVA after use of near LVAs		Reading speed after use of near LVAs
	OD	OS			OD	OS	OD	OS	
1	1.0	1.0	20-40 wpm	Monocular	+5 (glasses)	+5 (glasses)	0.1	0.1	>60 wpm
2	0.6	-	20-40 wpm	Monocular	+4 (monocular glasses)	-	0.1	-	>60 wpm
3	1.3	-	Cannot read school books without aid	Monocular	5× (20 D) stand magnifier (dimensions 58 mm.)	-	0.1	-	40-60 wpm
4	>1.6	-	Cannot read school books without aid	Binocular	Video magnifier, up to 12×174×90.3× 40 mm 5 inches LCD	-	0.8	-	20-40 wpm
5	1	0.9	<20 wpm	Monocular	+10 (binocular glasses) (12 D prism base in)	+10 (binocular glasses, 12 D prism base in)	0.1	0.1	40-60 wpm
6	>1.6	-	Cannot read school books without aid	Binocular	Video magnifier pocket viewer	-	0.7	-	40-60 wpm
7	>1.6	>1.6	Cannot read school books without aid	Binocular	Illuminated stand magnifier 10× (38 D), dimension of lens 35 mm (circular)		0.4	0.4	40-60 wpm
8	1.6	-	Cannot read school books without aid	Monocular	Video magnifier pocket viewer	-	0.5	-	>60 wpm
9	1.0	1.6	<20 wpm	Binocular	Rido Med (binocular glass mounted telescope for near) 2.5× distance 350 visual field 75/350 mm		0.1	0.6	40-60 wpm
10	1.3	1.3, bad contrast	Cannot read school books without aid	Binocular	Video magnifier pocket viewer		0.1	0.1	>60 wpm
11	0.8	0.8	20-40 wpm	Binocular	Labo clip 3× (7.75 D) over distance correction, distance 130 mm		0.1	0.1	>60 wpm
12	1.4	1.1	<20 wpm	Binocular	Stand magnifier 6× (24 D)		0.1	0.1	>60 wpm
13	1.3 bad contrast	-	Cannot read school books without aid	Monocular	Video magnifier pocket viewer	-	0.1	-	40-60 wpm
14	-	1.6	Cannot read school books without aid	Monocular	-	Video magnifier pocket viewer	-	0.1	40-60 wpm
15	1.6	1.5	Cannot read school books without aid	Binocular	Video magnifier pocket viewer	-	0.1	0.1	40-60 wpm

OD: Right eye; OS: Left eye; VA: Visual acuity; BCVA: Best corrected visual acuity; logMAR: Logarithm of minimum angle of resolution; wpm: Word number read per minute; LCD: Liquid crystal display.

patients. Improvement was demonstrated as increase in visual acuity by a least one line on the chart used either for distance or near, improvement of reading speed, and improvement of quality of life documented by questionnaire. Gothwal *et al*[10] have reported that children in correlation to grownups have a very high rate of successful low vision aids utilize, provided that aids are properly prescribed. To our knowledge, no previous studies published about management of visual impairment using LVAs following successful treatment of pediatric CNS tumors. Telescopic systems either monocular or binocular, were utilized to enhance distant vision. Low magnification telescopes are preferred by children due to their simplicity of manipulation and their larger field of view.

In the present study, 12 patients (80.0%) had far visual acuity of equal or better than 1.3 (logMAR) in the best seeing eye after use of LVAs. Utilization of telescopic systems by visually disabled school children ought to be promoted according to Haddad *et al*[11], even for school activities. Patients who accomplished visual acuity better than 20/400=(1.3 logMAR) will get a better opportunity of success with the utilization of optical aids[12]. That was evident in the present study as telescopic systems for far vision were prescribed and successfully used by children. Scanning eye movement is a part of adaptation for visual field enhancement was one of the main items of our training sessions. A patient with a 10 degrees static visual field can get a functional dynamic visual field of more than 50 degrees using scanning eye movements[13].

Near vision low vision aids were prescribed for all patients: the most frequently used aid in the present study was video magnifier (pocket viewer) in 46.7% due to its high magnification, better resolution, freedom to change head position, domination of contrast polarity and its suitability for patients with peripheral field defects. Two patients (13.3%) stopped using stand magnifiers as near aids towards the end

Table 3 Number and percentage of patients responding to each question with the degrees of difficulty of performing the visual tasks in the LV Prasad-functional vision questionnaire before and after the use of low vision aids

No.	Questions	Pre-LVAs scores, *n* (%)				Post-LVAs scores, *n* (%)				*P*
		2	3	4	9	2	3	4	9	
16	Do have difficulty in locating a ball while playing in the day light?		7 (46.7)	8 (53.3)			8 (53.3)	7 (46.7)		0.001
19	Do you difficulty in identifying colors (*e.g.* while colorings)?	4 (26.7)	5 (33.3)	6 (40.0)		7 (46.7)	5 (33.3)	3 (20.0)		0.02
5	Do you have any difficulty in copying from the blackboard while sitting on the first bench in your class?		0	15 (100)		2 (13.3)	4 (26.7)	9 (60.0)		0.03
10	Do you have any difficulty in finding the next line while reading when you take a break and then resume reading?		0	15 (100)			7 (46.7)	8 (33.3)		0.47
11	Do you have any difficulty in locating dropped objects (pen, pencil and eraser) within the classroom?		6 (40.0)	9 (60.0)			7 (46.7)	8 (53.3)		0.001
1	Do you have any difficulty in making out whether the person you are seeing across the road is a boy or a girl, during the day?		7 (46.7)	8 (53.3)			9 (60.0)	6 (40.0)		0.007
7	Do you have any difficulty in reading the other details on the bus (such as its destination?		3 (20.0)	12 (80.0)			6 (40.0)	9 (60.0)		0.04
8	Do you have any difficulty in reading your textbooks at an arm's length?		0	15 (100)			7 (46.7)	8 (53.3)		0.47
2	Do you have any difficulty in seeing whether somebody is calling you by waving his or her hand from across the road?		3 (20.0)	12 (80.0)		4 (26.7)	5 (33.3)	6 (40.0)		0.006
12	Do you have any difficulty in threading a needle?			1 (0.7)	14 (93.7)			3 (20.3)	12 (80.0)	0.2
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	15 (100)			7 (46.7)	8 (53.3)		0.47
9	Do you have any difficulty in writing along a straight line?		0	15 (100)		9 (60.0)	5 (33.3)	1 (6.7)		0.45
17	Do you have difficulty in applying paste on your tooth brush?		5 (33.3)	10 (66.7)			8 (53.3)	7 (46.7)		0.04
14	Do you have difficulty in climbing up or down stairs?		3 (40.0)	12 (60.0)			5 (53.3)	10 (46.7)		0.02
15	Do you have difficulty in lacing your shoes?		5 (33.3)	10 (66.7)			9 (60.0)	6 (40.0)		0.002
18	Do you have difficulty in locating food on your plate while eating?		6 (40.0)	9 (60.0)			10 (66.7)	5 (33.3)		0.04
6	Do you have difficulty in reading the bus numbers?		3 (20.0)	12 (80.0)			6 (40.0)	9 (60.0)		0.04
3	Do you have difficulty in walking alone in the corridor at school without bumping into objects or people?		6 (40.0)	9 (60.0)			9 (60.0)	6 (40.0)		0.03
20	How do you think your vision is compared with that of your normal-sighted friend? Do you think your vision is:									0.03
	As good as your friend's (0)			0				0		
	A little bit worse than your friend's (1)			4 (26.7)				7 (46.7)		
	Much worse than your friend's (2)			11 (73.3)				8 (53.3)		
13	How much difficulty do you have indistinguishing between 1 rupee and 2 rupee coins (without touching)?		6 (40.0)	9 (60.0)			9 (60.0)	6 (40.0)		0.03

The questionnaire was based on four parameters: distance vision (No.1-2, 4-7), near vision (No.8-10, 12-13, 15), color vision (No.17, 19), field of vision (No.3, 11, 14, 16, 18). Responses for each item rated on a 5-point Likert scale: 0=no difficulty, 1=little difficulty, 2=some difficulty, 3=great difficulty, 4=unable to perform the task due to visual reasons, 9=not applicable. LVAs: Low vision aids.

of follow up period due to limited field of view. The ordinary conventional aids are widespread because they are usually inexpensive, portable, and versatile and gives appropriate magnification in mild or moderate visual impediment however electronic devices despite their advantages were administrated less frequently because they were excessively costly, their

standby times were to some degree short and they were hard to repair if harmed[14]. Omar *et al*[15] recorded in their study that the most preferred near low vision devices were hand held magnifiers with percentage 54.2% of cases. Yet, another studies reported that stand magnifiers were the most frequently utilized. Haddad *et al*[11] reported that 2.8×26 mm manual and monocular distance telescopes for far (32.4%) and +38 D illuminated stand magnifiers for near (33.4%) were the most frequently utilized LVAs in their study of visual impairment secondary to congenital glaucoma.

Most of the patients in the present study reported their troubles with near and distance vision to be of equivalent significance as detected by their responses to the questionnaire with significant reduction across all domains in children. Those children had previous experience with normal visual performance since birth until the development of CNS tumors and their late effects on vision compared to those who had congenital visual disabilities dating since birth, they did not have a basis for correlation to mild, moderate or great difficulty since they usually perform the errand in one specific way. This was in agreement with Gothwal *et al*[10].

Statistical significant improvement of visual tasks regarding the parameters of far vision, color vision and field of vision was based on self-reporting of the functional abilities of visually impaired children using the validated (LV Prasade-FVQ) questionnaire, practitioner's evaluation of children activities by observation during the follow up visits in the clinic and also by the feedback from parents and teachers about daily and academic activities in this study.

In conclusion, LVAs rehabilitation was a markedly effective method of improving functional vision in children with visual impediment secondary to CNS tumors, provided that appropriate LVAs are prescribed according to their needs and visual rehabilitation accomplished.

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