CASE REPORT

A Multi-Modality Treatment Approach in Vision Therapy for a Patient with Form Deprivation Adult Strabismic Amblyopia and Nystagmus: A Case Report

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ABSTRACT

Background

Amblyopia is characterised by visual impairment along with compromised binocular visual function. Form deprivation amblyopia is a result of opaque media which results in obstruction of light. This obstruction of light prevents visual development. It is has traditionally been managed at early stage of life through occlusion therapy.

Case Summary

A 29-year old male presented to us, diagnosed with form deprivation adult strabismic amblyopia and nystagmus. Anterior segment evaluation showed pseudophakia in both eyes, and posterior segment was within normal limits. Stereopsis was absent. In-office vision therapy and home-based vision therapy was undertaken, which included optometric syntonic phototherapy, biofeedback mechanisms to improve nystagmus along with oculomotor skills, monocular fixation in a binocular field (MFBF) and binocular therapies in-office, and Amb-iNet at home.

Conclusion

A multi-modality treatment approach in vision therapy is presented, which resulted in improvement of visual acuity, stereopsis and other components of vision for an adult with form deprivation strabismic amblyopia and nystagmus.

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VDR is indexed in the Directory of Open Access Journals. Online access is available at **covd.org. https://doi.org/10.31707/VDR2021.7.1.p50.**

Pandey RK, Pandey P. A multi-modality treatment approach in vision therapy for a patient with form deprivation adult strabismic amblyopia and nystagmus: A case report. Vision Dev & Rehab 2021;7(1):50-9.

Keywords: biofeedback, Form deprivation amblyopia, nystagmus, syntonic phototherapy, vision therapy

Background

Amblyopia is a developmental disorder with binocular consequences. It has a prevalence of 2-5% of the population.[1-4] Uncorrected refractive error, anisometropia or, strabismus results in deprived foveal stimulation which causes amblyopia. The most overt sign of amblyopia is reduced visual acuity and foveal crowding, but it also presents as compromised binocular function including poor stereovision, reduction in contrast sensitivity, and poor spatial localization.[5-7]

Form deprivation amblyopia and strabismic amblyopia are more severe than other types such as anisometropic amblyopia or ametropic amblyopia. Causes of form deprivation amblyopia may be congenital cataract, corneal opacities, eyelid ptosis and vitreous haemorrhage. Unilateral non-accommodative infantile esotropia is also a cause of strabismus or suppression amblyopia.[8]

Form deprivation amblyopia is associated with the obstruction of light causing distorted images on the retina. This causes physiological alteration in the visual cortex which impacts the normal development of vision.[9] The obstruction leads to severe visual impairment or blindness if not treated.[10-12] If the obstruction is removed within the critical period of visual system development then the visual system has the capacity to recover visual function. When deprivation is not as severe, early intervention while desirable is not as critical.

Nystagmus is often associated with form deprivation amblyopia. Rogers et al. has reported that nystagmus could occur as a result of visual deprivation by cataract.[11] Uemura and Katsumi reported 17% of cases having some deformity in retina or optic nerve along with binocular congenital cataract due to which there is nystagmus and poor vision, whereas 83% is due to visual deprivation by unilateral cataract.[13] Most of the cases reported by Uemura and Katsumi involves management of form deprivation amblyopia in infants or children with the help of a contact lenses and occlusion therapy.[13] In such cases early detection and treatment are extremely important.[14] However, with recent advancement in clinical applications of evaluating infants and young children, early identification and treatment has become more effective.[15,16]

The following case involves form deprivation strabismic amblyopia with nystagmus, treated successfully in adulthood. It illustrates how a stepwise approach involving vision therapy and syntonic phototherapy helped improve visual acuity along with improvement in binocularity and stereopsis.

CASE REPORT

A 29-year-old male presented with a known case of form deprivation amblyopia and strabismus in his left eye since childhood. As per history, the patient had congenital cataract in both eyes and underwent cataract surgery with intraocular lens implantation in his right eye. This was followed by intraocular lens implantation in the left eye 6 months later. In 2018 an ophthalmologic examination showed a constant left esotropia of 18Δ at distance and near, along with nystagmus in both eyes.

Posterior segment evaluation and ocular coherence tomography (OCT) reports were within normal limits. The patient was prescribed progressive addition lenses along with patching of his right eye for 2 hours/ day. His eyeglasses prescription was OD-8.00 -1.25 x 160 and OS -8.00 -2.50 x 25. Visual acuity with his eye glasses was OD 6/9(20/30) and OS 6/60(20/200). With an add of +2.00 his near visual acuity was OD N6 (20/40) and OS N12 (20/80). In January 2019 he was prescribed a computer-based home vision therapy program for his amblyopia. After 2 months of use there was no improvement noticed so he discontinued the treatment.

Diagnostic Data

The clinical examination data is listed in Table1. On examination, visual acuity with prescription was OD 6/9(20/30), N6(20/40) and OS 6/60(20/200), N12 (20/80). His subjective refraction revealed no change hence we advised him to continue with the same prescription eye glasses. Anterior and posterior segment were within normal limits except for the previously mentioned pseudophakia. Cover test revealed esotropia of 16Δ at distance and near along with bilateral latent nystagmus. Extra-ocular motility was unrestricted. Stereopsis was absent on the Randot stereo test. Suppression of the left eye was noted during both phorometry and Worth 4 dot testing at distance and near. Visuoscopy revealed 2Δ (approximately 1 degree) of unsteady nasal eccentric fixation in his left eye. SCCO Oculomotor Test revealed reduced performance for saccades and pursuits along with unsteady fixation in each eye. The functional visual field of his left eye as reported by the patient was constricted. He initially could only see half of the entire screen while standing centered in front of the Sanet Vision Integrator (SVI) monocularly.

Diagnosis / Findings

- Pseudophakia OD/OS
- Bilateral form deprivation amblyopia secondary to congenital cataract OD/OS
- Constant esotropia OS
- Nystagmus OS with latent nystagmus OU

Prognosis

The patient's main goal for vision therapy was to improve visual acuity in his left eye. His secondary goal was to improve depth perception so as to enjoy 3D games and 3D movies.

We recommended he continue with his current eye glasses prescription but stop wearing his current progressive spectacle lenses. We prescribed two separate pairs of eye glasses for distance and near respectively. As the patient's right eye visual acuity was good at 6/9(20/30) compared to the left which was near legal blindness at 6/60 (20/200), we decided not to treat his right eye separately but to focus on the left eye and ultimately on binocular integration. We recommended the patient proceed with vision therapy in combination with syntonic phototherapy to improve visual acuity and to expand his constricted visual field (OS) respectively. We also recommended oculomotor therapies to reduce the frequency and magnitude of strabismus in his left eye. We gave a guarded prognosis about his visual condition and thoroughly explained the treatment process. We proceeded with treatment once the patient accepted the guarded prognosis and agreed with the treatment plan.

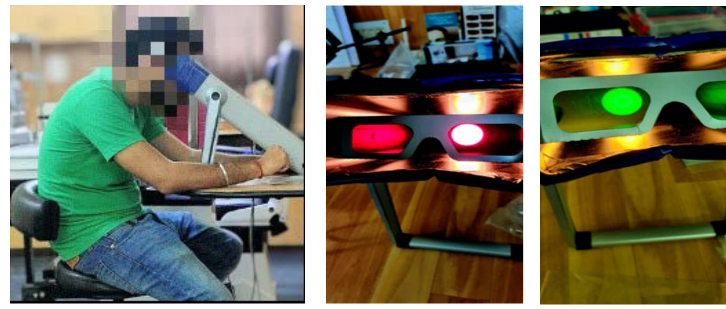
Treatment

The overall treatment plan was subdivided into 3 phases:

1st Phase:

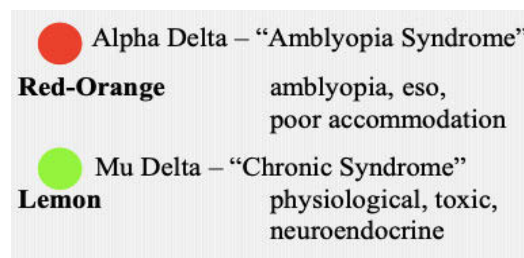
The primary clinical goal was to improve monocular visual skills including saccades, pursuits and eccentric fixation along with improvement of visual acuity, expansion of functional visual field and reduction of the nystagmus in his left eye. We started with daily in-office vision therapy sessions along with 20 minutes per day of home vision therapy utilizing the Amb-iNet computer program.

In office vision therapy sessions were administered for one hour each day. We started each session with 20 minutes of syntonic phototherapy using the filter combinations of Alpha-Delta for 10 minutes followed by Mu-Delta for 10 minutes. (Figure 1).

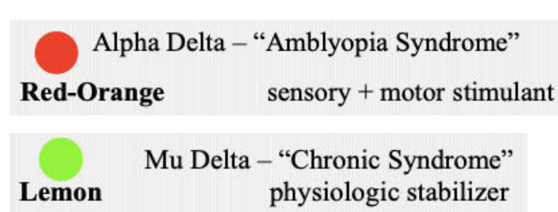


1a 1b 1c

Figure 1a. Syntonizer; ***Figure 1b.*** Alpha-Delta Filter; ***Figure 1c.*** Mu-Delta filter



The selection of Alpha- Delta & Mu- Delta filters was done based on the principles of Syntonic syndromes. As per the Lazy Eye Syndrome Alpha Delta(red-orange) acts as a strong sympathetic stimulant to treat esotropia or amblyopia. This filter combination is thought to build electrical charge in the cell membranes in order to break through synaptic resistance to overcome amblyopia and binocular suppressions. Diagnosis also may include functional visual field constriction, abnormal retinal correspondence and poor fusion.[17]



Alpha-Delta: Red and Orange combination

Mu-Delta: Green and Yellow combination

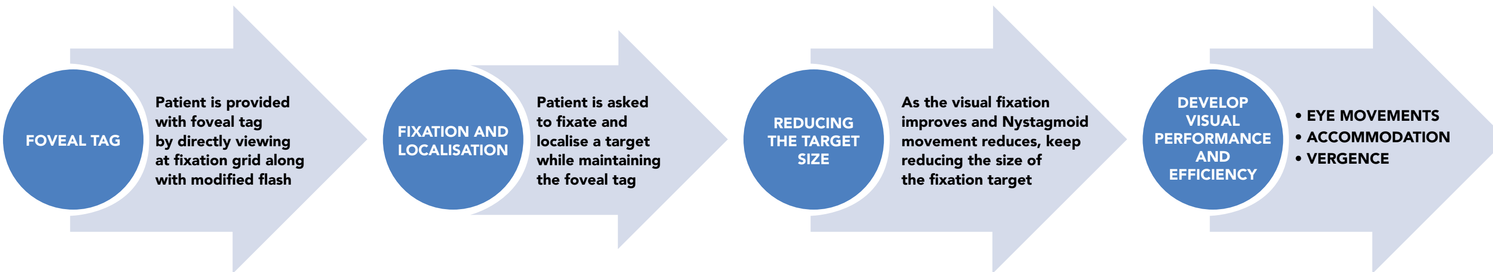


Figure 2. Nystagmus Treatment Protocol

Figure 3. Biofeedback mechanism for controlling Nystagmus

Alpha Delta is followed by Mu -Delta(lemon) is a physiologic stabilizer and detoxifier that is used for individuals with chronic or degenerative health problems that are organic, metabolic, toxic, or from past trauma. Symptoms of this "Chronic Syndrome" may include fatigue, loss of visual stamina, asthenopia, headaches, photophobia, and transient blur.[17]

An approach was taken to reduce nystagmus and improve visual fixation through biofeedback mechanisms according to our Nystagmus Treatment Protocol (Figure 2). The patient is provided with a monocular foveal tag monocularly through a modified flash. This is followed by having the patient looking directly into a direct ophthalmoscope grid over a period of 5- 10 minutes. This was repeated during each session for 15 sessions (Figure 3).

After 15 sessions there was a marked reduction in his nystagmus. At that point, we fine-tuned fixation by combining visual feedback with tactile feedback. The patient was again provided with a monocular foveal tag in his left eye and asked to fixate and point to visual targets at 40 cm. The visual targets were progressively reduced in the size from N12(20/80) print size to N6(20/40) print size over the course of 15 sessions. This after-image technique allows the patient to use direct visual feedback to monitor changes in foveal fixation and relative eye movements.

Thus, the patient visualizes his fixation stability. After one month of rigorous training the patient was exhibiting more significantly controlled nystagmus in his left eye.

Once his nystagmus was better controlled, we moved to treat eccentric fixation in his amblyopic eye by the Fast-Pointing Method on the Sanet Vision Integrator (SVI) Rotator module. He had to quickly touch as many of the rotating targets as possible within an initial set time of 5 minutes which was then gradually reduced to a set time of 2 minutes along with gradual reduction of the target size over 20 sessions.

In the later sessions, therapies for stabilizing and addressing oculomotor deficits such as saccades and, pursuits were carried out. These included the SVI saccades module, Hart Chart, Marsden Ball, and pegboard rotator.

After completion of 50 sessions of in-office-based vision therapy, a progress evaluation was conducted. At distance best corrected visual acuity in his left eye improved from 6/60 (20/200) to 6/18 (20/60). At near it improved from N12 (20/80) to N9 (20/50). Fixation behavior in his amblyopic eye was well centered, steady, maintained and his latent nystagmus was more controlled. Eye movements (saccades and pursuits) were now normalized in his left eye and his functional visual field expanded. He could now see the entire SVI screen when viewed monocularly through his left eye. On cover test, his esotropia reduced from 16Δ to 8Δ at distance and near. He was advised to continue 20 minutes of daily home vision therapy utilizing Amb-iNet.

2nd Phase:

In the second phase of in office vision therapy treatment, our primary clinical goal was to further reduce suppression of the patient's left eye to promote binocularity.

Anti-suppression training was done with the penlight dissociation method. We placed a 8Δ of vertical prism over his right eye while he viewed the penlight at a distance of 40 cm that was gradually increased to a distance of 3 meters. We first initiated the technique in a dark room gradually progressing to normal room lighting.

We performed monocular fixation in a binocular field (MFBF) therapy using GTVT red-green charts and using red green anti suppression activities on the SVI with a red lens placed over his right eye. (Figure 4).

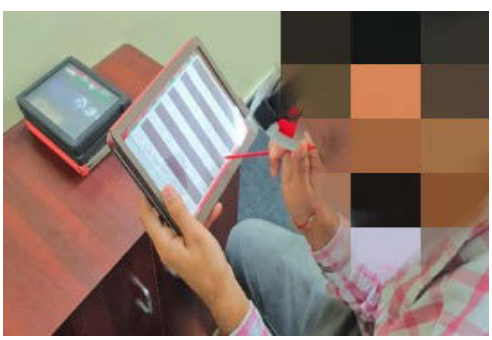


Figure 4a. GTVT – Charts

Figure 4b. Saccadic Fixator

Figure 4c. Sanet Vision Integrator (SVI)

Brock String techniques were incorporated to better establish centration and fixation along with promoting vergence and binocularity. Cheiroscopic tracing was performed on the Computer Orthoptics VTS4.

After 35 additional sessions of in-office vision therapy the patient's best corrected visual acuity OS improved only slightly further to 6/18+2 (20/60+2), even though suppression was decreasing.

The patient reported diplopia with Worth 4 Dot testing at both distance and near, but reported suppression at distance (3 meters) with smaller targets of the VTS4. Cover test revealed 6^ esotropia at distance and near.

3rd Phase:

In the 3rd phase of in office vision therapy, our primary goal was to improve binocularity along with increasing vergence ranges.

Binocular vision therapy activities were initiated with the Bernell's BC 500 Tranaglyph series followed by the BC600 Tranaglyph series of cards. We started at the patient's subjective angle to promote sensory fusion and then gradually incorporated motor fusion to increase his vergence ranges (Figure 5).

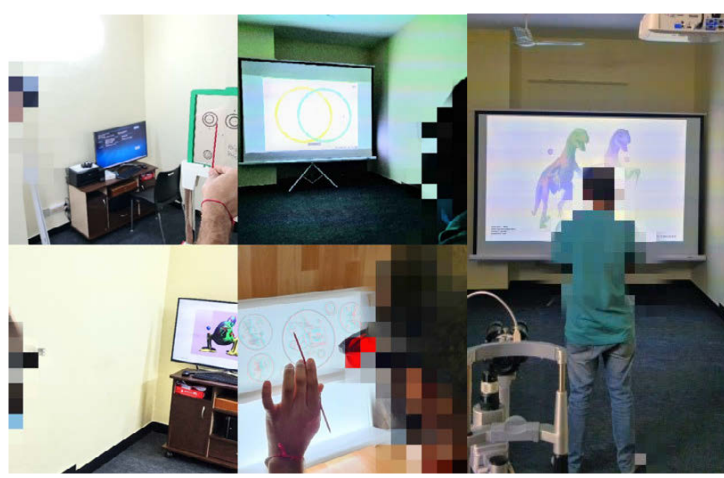


Figure 5. Binocular vision therapy activities

The VTS-4 vergence targets were used to increase his vergence ranges with emphasis on base-in range while establishing all the binocular cues. Initially vergence activities were started at near, and then gradually increased up to a distance of 3 meters.

In later sessions free space eccentric circles fusion cards were used to enhance the patient's fusion ability in free space.

Toward the end of the 35th session of this 3rd phase and with a total of 120 in- office sessions completed, a final progress evaluation was conducted. These results are summarized in the final outcome section. The patient was advised to continue his home vision therapy program with Amb-iNet set to binocular mode, along with vergence therapies utilizing vectograms and free space eccentric circle cards as his maintenance protocol. The patient was informed about the need for periodic follow-up after 3 months, 6 months and 1 year.

Final Outcome:

During his final VT evaluation, after 120 in-office vision therapy sessions, a subjective refraction was performed. He was prescribed OD -8.00-1.00x160 and OS -8.00-2.25x25 with an add of +2.50 diopter sphere OU. The patient's visual acuity in his left eye improved from 6/60 (20/200) at the outset to $6/18^{+2}$ (20/60+2). His previously constant left esotropia of 16^ reduced to orthophoria at distance and 2-4Δ of esophoria at near (Figure 6). The SCCO Oculomotor Test revealed normal pursuits and saccades.

Pre-Vision Therapy

Post-Vision Therapy

Figure 6

Worth 4 Dot testing improved from constant suppression of his left eye to fusion of the dots between the range of 16 inches out to to 20 feet. The patient's functional visual field expanded. He could now see the entire SVI screen when viewed monocularly through his left eye. Random Dot Stereopsis testing improved from absent to 500 secconds of arc. Phorometry testing, which initially showed suppression OS, improved to a BI blur, break and recovery of X/12.5/6.5.Table 1 provides an overview of his testing pre- and post-therapy.

Table 2 and 3 provide the in-office and home-based vision therapy activities used during for treatment.

The patient reported improved depth perception while doing the manual vergence module on VTS4. He also reported better comfort while working on his computer. Both the patient and his family were extremely happy with his progress during and following his vision therapy program. He was advised about the need for periodic follow-up after 3 months, 6 months and 1 year.

DISCUSSION

This case report demonstrates a multimodal treatment approach in vision therapy to improve visual acuity and binocularity for a patient diagnosed with form deprivation amblyopia with strabismus and nystagmus. The multimodal treatment approach included optometric syntonic phototherapy, biofeedback to reduce nystagmus, the Fast Pointing Method on the Sanet Vision Integrator for eccentric fixation, MFBF therapy to reduce suppression and binocular vision therapies to improve fusional vergence ranges were performed.

Syntonic phototherapy is used for patients with deficits in visual acuity, oculomotor skill, binocularity, accommodative facility and who demonstrate a constricted functional visual field. Patients with strabismus often demonstrate a constricted functional visual field through the deviated eye that can be expanded with syntonic phototherapy. As the visual field is expanded, normal binocular vision is easier to achieve.[17-19] We know that light is used to trigger photoreceptors cells of our skin or eyes which then stimulates photosensitive elements in the

Table 1: Diagnostic data Pre- Vision Therapy and Post- Vision Therapy

Clinical test	Pre-Therapy	Post-Therapy
Spectacle Rx	OD: -8.00/ -1.25X160	-8.00/ -1.00 X 160
	OS: -8.00/ -2.50 X 25 ADD: +2.00 DSPH	-8.00/ -2.25 X 25 ADD: +2.50DSPH
Visual Acuities		
OD(Distance, Near):	6/9, N6	6/9, N6
OS(Distance, Near)	6/60, N12	6/18+2, N9
Cover Test		
Distance	16Δ ESO	ORTHO
Near	16Δ ESO	2-4 ΔEsophoria
Final Acceptance Distance Power		
OD(Distance)	-8.00/- 1.00 X160	
OS(Distance)	-8.00/-2.25 X25	
Final Acceptance Near Power		
OD(Near)	-5.50/-1.00X160	
OS(Near)	-5.50/-2.25 X25	
WFDT	Suppression OS (at distance and near)	Fusion (at distance and near)
Binocular Testing:		
Base Out(D) – VTS4	SUPPRESSION	28/25(Break/Recovery)
Base In(D)-VTS 4	SUPPRESSION	12.5/6.5(Break/Recovery)
Base Out(N)- VTS 4	SUPPRESSION	31/28(Break/Recovery)
Base In (N) – VTS 4	SUPPRESSION	15/12(Break/Recovery)
SCCO(Fixation)	3+,1+,3+(OD,OS,OU)	4+,4+,4+(OD,OS,OU)
SCCO(Pursuits)	3+,2+,2+(OD,OS,OU)	4+,4+,4+(OD,OS,OU)
SCCO(Saccades)	3+,2+,2+(OD,OS,OU)	4+,4+,4+(OD,OS,OU)
Score 3+ - 4+= Pass		
1+-2+= Fail		
Stereopsis	None	Patient was able to perceive depth while doing VTS-4 stereopsis module and with Tranaglyph BC 500 & 600 series
Visuoscopy		
OD	Central fixation, steady	Central fixation, steady
OS	2^Nasal eccentric fixation, unsteady-(L.E)	Central fixation, steady
Performance Field		
OD	Normal	Normal
OS	Constricted– patient was able to only see half of the entire Sanet Vision Integrator (SVI) screen while standing centered in front of the screen and viewing it monocularly.	Normal- patient was able to see the entire screen while standing centered in front of the screen and viewing it monocularly and while doing therapy on SVI.

Table 2: In- Office Optometric Vision Therapy Activities

Binocular/Anti-Suppression	Oculomotor	Monocular Fixation	Syntonics Phototherapy
Vectogram	Space fixator	Fast Pointing Method for eccentric fixation	Alpha-Delta for 10 minutes followed by Mu-Delta for 10 mins (Total 20 mins)
R/G luster with white board	MFBF'hflhGTVT Chart8.5'X11" and SVI(red patch OS)	BioFeedback mechanism to Conrol Nystagmus and improve Fixation	
R/G Pen light dissociation method for diplopia awareness	R/G Bernell sticks (saoorlls)		
R/G Tranglyph	Sanet Vision Integrator Marsden Ball activities		
R/G Maze with flashlight and red acetate (red glasses OS)	Saccadic Fixator		
R/G Maze with red marker	Standing Peg Board Rotator		
MFBF with BTVT chart 8.5"x11" and SVI (red patch OD)			
VTS-4 Free Space Eccentric Circles			
R/G with Saccadic Fixator			
Brock String			

Video 1. Pre-Vision Therapy – Nystagmus.

Video 2. Post Vision Therapy – Reduced and much controlled Nystagmus.

blood and photoreceptive areas in the brain through the retinal vascular beds and through the optic nerve via the rod and cone pigments, or directly from retina through the optic nerve.[18] In 1993, Robert Michael Kaplan concluded that syntonic phototherapy increases the visual field and academic performance in learning disabled children.[20] Spitler postulated that most binocular and accommodative disorders were determined by imbalance in the autonomic nervous system. Light frequencies balance the autonomic nervous system which in turn plays a supportive role in vision.[21]

Monocular fixation in a binocular field (MFBF) was used to reduce suppression. With the use of anaglyphic filters, these activities allow only the amblyopic eye to see stimulus details while both eyes receive peripheral stimuli.[22] The amblyopic eye usually contributes to binocular vision dysfunction that often includes suppression.

Since this has been shown to be reversed by the GABA(A) antagonist bicuculline on signal-receiving cells, we know that suppression is mediated by inhibitory interaction in primary visual cortex.[23,24] GABA(A) is responsible in inputs of suppression from the amblyopic eye within the primary visual cortex and plays a key role in brain plasticity.[24-26]

Recent emerging research with a binocular approach using dichoptic therapy has shown promising results in amblyopia through the unlocking of binocular visual functions. The theory of dichoptic therapy is based on the principle of binocular circuitry from the amblyopic eye being actively suppressed by the non-amblyopic eye.[27] For treatment, the amblyopic eye is shown higher contrast images than the non- amblyopic eye.[28] As suppression reduces, visual acuity improves along with binocular vision function and the contrast difference in both eyes also reduces.[29] Therefore in our approach to vision therapy, syntonic phototherapy, biofeedback and MFBF were followed by additional binocular vision therapies to improve vergence ranges and binocular vision function.

CONCLUSION

This case illustrates the importance of a multimodal approach to treating form deprivation amblyopia that includes strabismus and nystagmus. Treatment included syntonic phototherapy to expand a constricted functional visual field, biofeedback to control nystagmus, MFBF activities to remove suppression, along with binocular therapies to improve binocular vision function. In-office and home-based vision therapy was prescribed, as this combination of therapies supports the opportunity for a better outcome. In this case, 120 in-office sessions were required. Home based activities included syntonic phototherapy, peripheral awareness activities and computer based MFBF therapy. We recommend this multimodal approach for the effective management of form deprivation strabismic amblyopia with nystagmus.

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