ARTICLE

A Combined Approach of Syntonic Phototherapy along with Vision Therapy in Treatment of Rod-Cone Dystrophy: A Ray of Hope - Case Series Report

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ABSTRACT

Background

Rod-Cone Dystrophies (RCDs) are characterized by the dominant clinical features of rods manifestation predominantly over the cones such as night blindness and peripheral vision worsening that leads to restricted activities of daily living. There are no medical or surgical treatments available for this disease. A combined approach of syntonic phototherapy along with the vision therapy may be a viable treatment option for the improvement in visual efficiency skills and visual function of RCD patients.

Case Reports

Case 1: A female, aged 47 years old, diagnosed with severe RCD and complained of poor sight and difficulty in seeing at night in both eyes along with progressive diminution of vision for the past ten years.

Case 2: A boy, 11 years of age, diagnosed with severe RCD and presented with major complaints of progressive vision loss, photophobia and falling short in school performance.

Both patients were recommended for a combined treatment approach of syntonic phototherapy combined with vision therapy to be completed in our centre.

Conclusion

These two patients showed significant improvement in visual acuity, oculomotor motility and visual field. Further research is recommended to enrich our understanding on the use of syntonic phototherapy along with vision therapy in managing patients with RCD which otherwise lacks in specific medical or surgical treatment.

BACKGROUND

Rod-Cone Dystrophies (RCDs) are a group of progressive diseases portrayed by the primary involvement of rod pigments and sometimes may include simultaneous involvement of both rods and cones. RCD is described by the dominant clinical features of rods manifestation

predominantly over the cones such as night blindness and worsening of peripheral vision that leads to restricted independent mobility, or at times either combined with or followed by cone manifestations of impaired color vision (dyschromatopsia), blind spots (scotomas) in the center of the visual field, and partial peripheral vision loss. As the condition progresses it may lead to involuntary eye movements (nystagmus) and may results in severe visual impairment or blindness.[1] In RCDs, degeneration of rod photoreceptors precede cone photoreceptors' degeneration whereas in Cone-Rod Dystrophies (CRDs), there is a reverse in the sequence of events. Usually, CRD is severe and rapid in clinical course, compared to RCD, resulting in early onset of legal blindness and disability.[1] However, at the terminal stage of the disease, CRD is not different in clinical features from that of RCD.

RCD is chiefly an inherited genetically heterogeneous group of retinal dystrophies alternatively termed as pigmentary retinopathy, retinitis pigmentosa, and tapetoretinal degeneration. It belongs to the subset of pigmentary retinopathies. Inherited rod function disorder is categorized as stationary or progressive.[2,3] The stationary disorder is either congenital or early infantile presentation and gives rise to purely rod dysfunction. Progressive rod dystrophies are of later onset with the involvement of cone photoreceptors. Onset age and the prognosis of RCD are subjected to the pattern of inheritance.

Clinical findings of RCD are comprised of pigment clumping or bone spicule pigmentation, retinal arteriolar narrowing, epiretinal membrane formation, waxy pallor of the optic nerve, choriocapillaris (originating from midperiphery of the retina with preservation of the RPE in the macula), epiretinal membrane formation, posterior subcapsular cataract, cystoid macular edema (CME), and atrophy of the RPE.[4]

At present, medical or surgical treatments are unavailable for RCDs for preserving the vision. It has been long postulated that the biological process of degeneration could be slowed down by retinal implants, gene therapy and stem cell therapy. However, these management approaches are still in the process of animal investigation testing.[5-7] Hence, it would be worthwhile to design an effective therapy with the highest level of safety that would pass through further clinical trials.

Syntonic phototherapy has been defined as the ocular branch of science dealing with the application of predetermined light frequencies, through the eyes, to stimulate and balance the autonomic nervous system which in turn plays a supportive role in vision.[8] Syntonic optometry (introduced by H.Riley Spitler in the year 1920) employs non-polarized, non-coherent and non-narrow band light entered into the eyes for the treatment of brain injury, learning disability, mood and developmental syndromes, headache, strabismus, and eye pathology. Syntonics can be either a local or nonlocalized therapy that is primarily concerned with the effect on neurologic and neurobehavioral functions. Imbalances of the autonomic nervous and endocrine systems are linked with systemic (chronic), emotional and mental, and visual illness conditions. The syntonic principle has established that particular light frequencies entered into the eyes could restore the imbalances though direct retinal input to thalamic and hypothalamic centres (regulatory), and thereby improving or rectifying the visual dysfunction at their light sources. Eyes allow direct, non-invasive presentation of light to the retinal blood supply, and then to retinal photoreceptors (non-visual) that triggers circadian and other brain centers. Generally, patients undergo the prescribed color treatment (20 minutes per day) for 20 sessions. Parameters such as pupil and binocular testing, visual field, medical history and present symptoms influence the decision of syntonic filter to be applied. It has been clinically employed in the field of optometry for more than seven decades and implicated for treating visual dysfunctions such as amblyopia, strabismus, headaches, and the visual consequences of brain injury.[9] On the other hand, vision therapy or vision training

represents a precise, sequential, sensory motor perpetual stimulation prototype and regimens that are employed to expand vision skills such as eye coordination and eye movement control. Moreover, there are adequate numbers of systemic vision therapy studies underlying the scientific background where controlled clinical trials were performed.[10-12]

Our previous study has already enlightened the clinical benefits of stepwise approaches involving the combination of vision therapy and syntonic phototherapy in the improvement of visual acuity together with binocularity and stereopsis in form deprivation amblyopia and strabismus patients.[13] Hence, a combined approach of syntonic phototherapy along with vision therapy might be a viable treatment option for improvement in RCD patients, considering their increasing incidence among the population and the absence of medical and surgical treatment.

We report a cases series of two patients who have been diagnosed with a severe grade of RCD and presented with major complaints of diminution of vision involving both eyes. Both patients have been successfully treated with a combination of syntonic phototherapy along with vision therapy leading to improvement in vision abilities (visual functions). Both patients showed improvements in visual acuity, oculomotor motility and visual field. To the best of our knowledge, this is the first report documenting enhancement in visual acuity, oculomotor motility and visual filed through synchronous therapy approach of syntonics phototherapy along with vision therapy.

CASE REPORTS

CASE 1

A female, aged 47 years old, diagnosed in an eye hospital with RCD at age 40 visited Caring Vision Therapy & Neuro-vision Rehabilitation Centre at Chennai with a major complaint of progressive diminution of vision. She first noticed vision diminution eight years before and consulted the eye hospital where she was

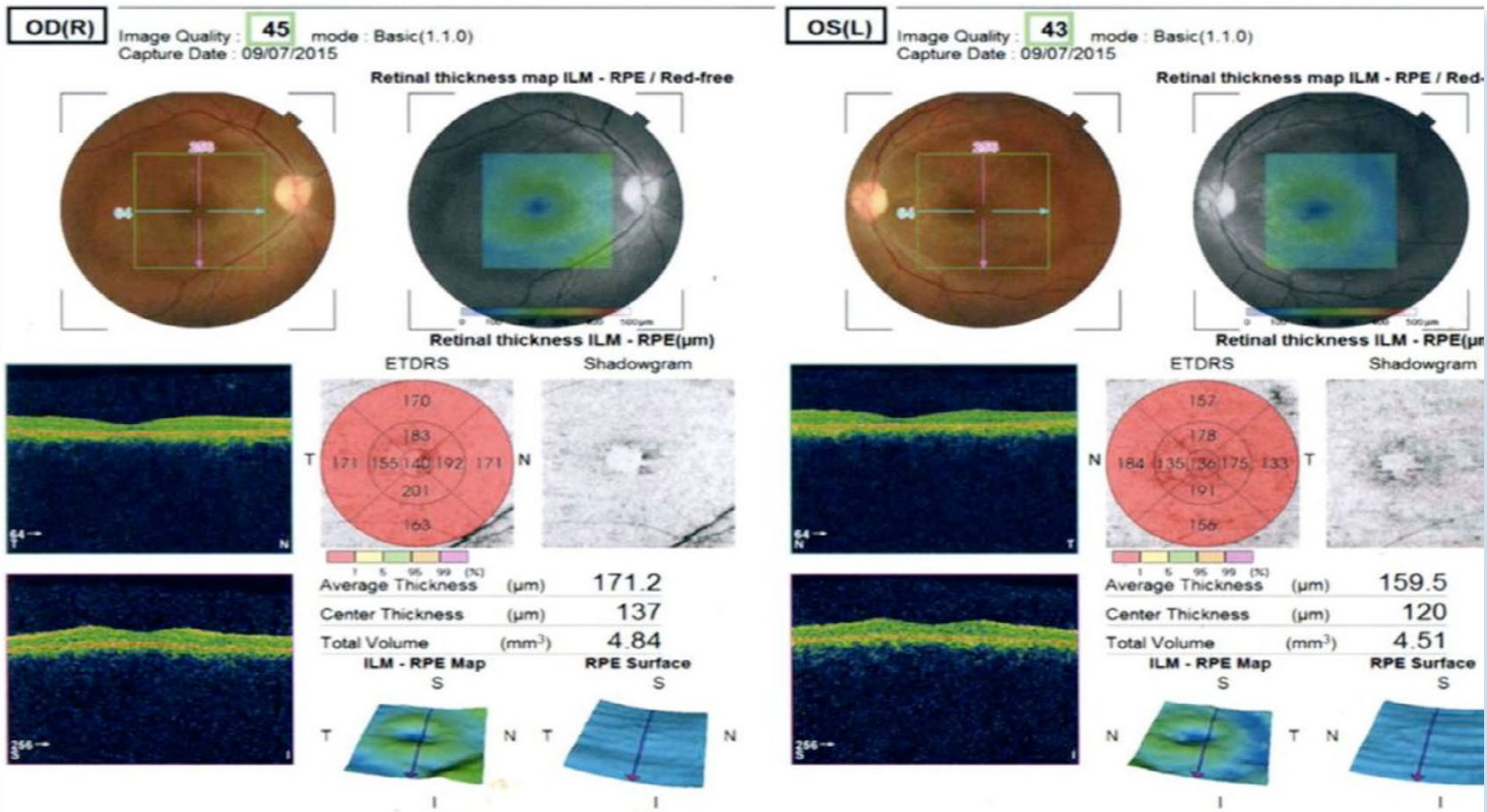

Figure 1. OCT report indicates: Normal Vireoretinal Interface, Altered Foveal Contour, and Foveal Thinning Noticed in both eyes. OD foveal thickness is 124 microns, OS foveal thickness is 123 microns, Normal Inner Retina seen, Normal RPE & Choriocapillaries seen, loss of is-os junction layer is evident. Foveal thinning and loss of is-os layer in OCT is a sign of RCD.

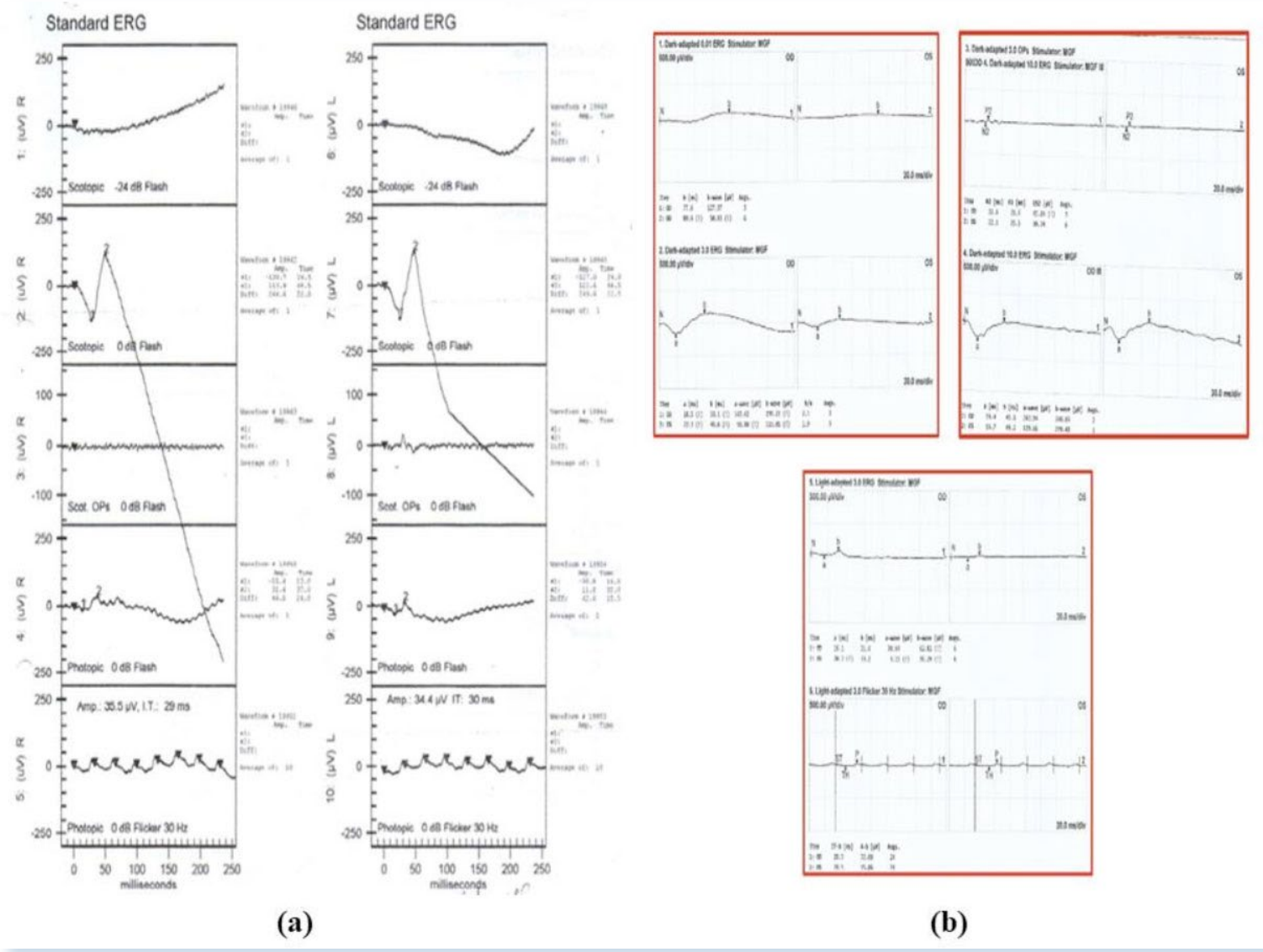

Figure 2. ERG of (a) Pre syntonic phototherapy with vision therapy (b) Post syntonic phototherapy with vision therapy

diagnosed with RCD. On her first consultation to the eye hospital, the patient underwent fundus examination, vision field testing and Optical Coherence Tomography (OCT) along with Magnetic Resonance Imaging (MRI) and X-ray to rule out a pituitary mass in view of her hypomenorrhea history. MRI revealed normal findings with no specific intra-cranial pathology and X-ray ruled out any pituitary mass. Fundus examination revealed mild disc pallor and the presence of macular changes which were suggestive of Bull's eye maculopathy involving both eyes. OCT report showed signs of foveal atrophy in both eyes as shown in Figure 1. A year later, the patient went for the follow-up to the same eye hospital for repeat fundus examination, visual acuity testing and Electroretinography (ERG). Her visual acuity was recorded as 6/12 in both eyes. Full-Field Electroretinography (f-FERG) detected an extinguished wave pattern in the dark-adapted scotopic response. Implicit time and amplitude of both A wave and B wave were delayed. There was a reduction in dark adapted combined response. Gross reduction in amplitude of Oscillatory Potential (OP) in both eyes was also noticed in scotopic response. A normal A-wave implicit time and delayed B-wave implicit time were noted. The amplitude for A wave and B wave were noted be reduced and grossly reduced in light adapted cone response in both eyes. There were reduced amplitudes with normal implicit time in both eyes in 30 Hz Flicker Test. The above stated characteristic features were

suggestive of severe RCD involving both eyes as illustrated in the Figure 2(a).

Her parents had a consanguineous marriage. No one in her family had either CRD or RCD or any genetic disorder. The patient was unwilling to go for genetic analysis. Based on the established clinical history and laboratory diagnosis, her disease was categorized as RCD. Five years from her diagnosis, she followed up at the eye hospital where her visual acuity status was found to be further deteriorated to 6/18 and other electro-diagnostic tests reconfirmed the RCD diagnosis in both of her eyes. Between the last and the current follow-up at the eye hospital, she reported to be under herbal treatment for 3 years but with no significant improvement as witnessed by the deterioration in her repeat visual acuity testing.

The patient was provided with a spectacle Rx of +1.25 +0.25 x 90 and +1.75 + 0.50 x 90 in right and left eye respectively. Visual acuity with the eyeglasses was recorded as 6/24 in both eyes. With a near add of +2.00, near visual acuity was N12 in both eyes.

The details of clinical investigations are presented in Table 1. On examination her subjective refraction was found to be OD: +1.50 DSPH, Add: +2.00 and OS: +2.50/ -0.50 X 90, Add: +2.00. Visual acuity with the new prescription was OD 6/24, N12 and OS 6/24, N12. There was no considerable change in her visual acuity but, she was advised to proceed with the new eyeglass's prescription. The Extra-Ocular Motility (EOM) was found to be unrestricted. Random dot stereo test was identified to be negative for stereopsis. Pupil reaction to light was brisk, and Round and Reacting to Light (RRTL) on both eyes. Intraocular pressure (IOP) was reported to be 13mm of Hg and 14mm of Hg in the right and left eye respectively.

Oculomotor testing revealed reduction in both pursuits and saccades. The Southern California College of Optometry (SCCO) scoring for each eye is shown in Table 1. Anterior segment examination was within normal limits. Alpha-Omega pupil assessment revealed a grade four

Table 1: Comparison of diagnostic data pre and post syntonic phototherapy and vision therapy treatment – Case 1

Diagnostic Data		
Clinical Test	**Pre-Therapy**	**Post-Therapy**
Spectacle Rx	OD: +1.25/ +0.25X90	
	OS: +1.75/ +0.50 X 90 ADD: +1.00 DSPH	
Visual Acuities		
OD(Dist., Near)	6/24, N12 (Aided)	6/12, N6 (Aided)
OS(Dist., Near)	6/24, N12 (Aided)	6/12, N6 (Aided)
EOM		
OD	Full	Full
OS	Full	Full
Final Acceptance		
OD		+1.50 DSPH ADD: +2.00
OS		+2.50/ -0.50 X 90 ADD: +2.00
Pupil		
OD	BRISK, RRTL	BRISK, RRTL
OS	BRISK, RRTL	BRISK, RRTL
IOP		
OD	13.00 mm of Hg	14.00 mm of Hg
OS	14.00 mm of Hg	
Oculomotor		
SCCO (fixation) SCCO (Pursuits) SCCO (Saccades) Score 3^+- 4^+= Pass 1^+- 2^+= Fail	4^+, 1^+, 3^+ (OD, OS, OU) 3^+, 2^+, 2^+ 3^+, 2^+, 2^+	4^+, 4^+, 4^+ 4^+, 4^+, 4^+ 4^+, 4^+, 4^+
Anterior Segment	All normal	All normal
Alpha – Delta pupil assessment	Grade 4 (OD/OS)	Grade 1 (OD/OS)
Direct Ophthalmoscopy (Fundus Exam) OD	Macula/Foveal Reflex: Atrophy, Remarks: Cone Dystrophy	
OS	Macula/Foveal Reflex: Atrophy, Remarks: Cone Dystrophy	
Functional Visual Field Test (Spectron Visual Field Charter)		
OD	Reduced by 45%	Enlarged & Normal
OS	Reduced by 45%	Enlarged & Normal
ERG OD	Severe rod-cone dystrophy	Early retinal function loss
OS	Severe rod-cone dystrophy	Rod-cone dystrophy but values improved as compared to past ERG test done in 2015

response (rapid re-dilation after the penlight stimulus). Here it is worth noting that in pupil assessment, the alpha omega test provides information regarding autonomic nervous system function at a specific time as well as indicating whether the system is balanced or dominant specific to either the sympathetic or parasympathetic system.

Ophthalmoscopy revealed the similar findings of macular and foveal atrophy with thickened blood vessels suggestive of cone dystrophy in each eye. Her fundus photo is attached (Figure 3).

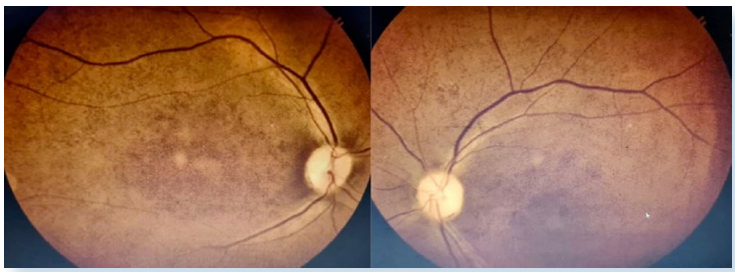

Figure 3. Fundus photos illustrate the presence of Rod-cone Dystrophy in both eyes.

Functional visual field testing was done as shown in Figure 4. Functional visual field charting to determine any level of visual field constriction was performed and the percentage of visual field constriction was found to be equal in distribution in both of the eyes. They were both reduced by 45% each as shown in Figure 5 (a) and 5 (b).

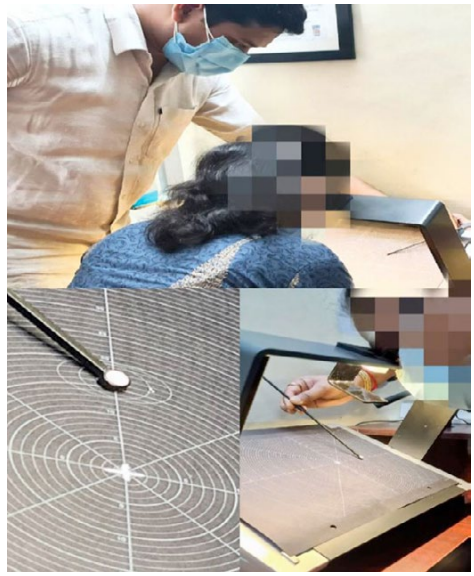

Figure 4. Illustration of functional visual field testing

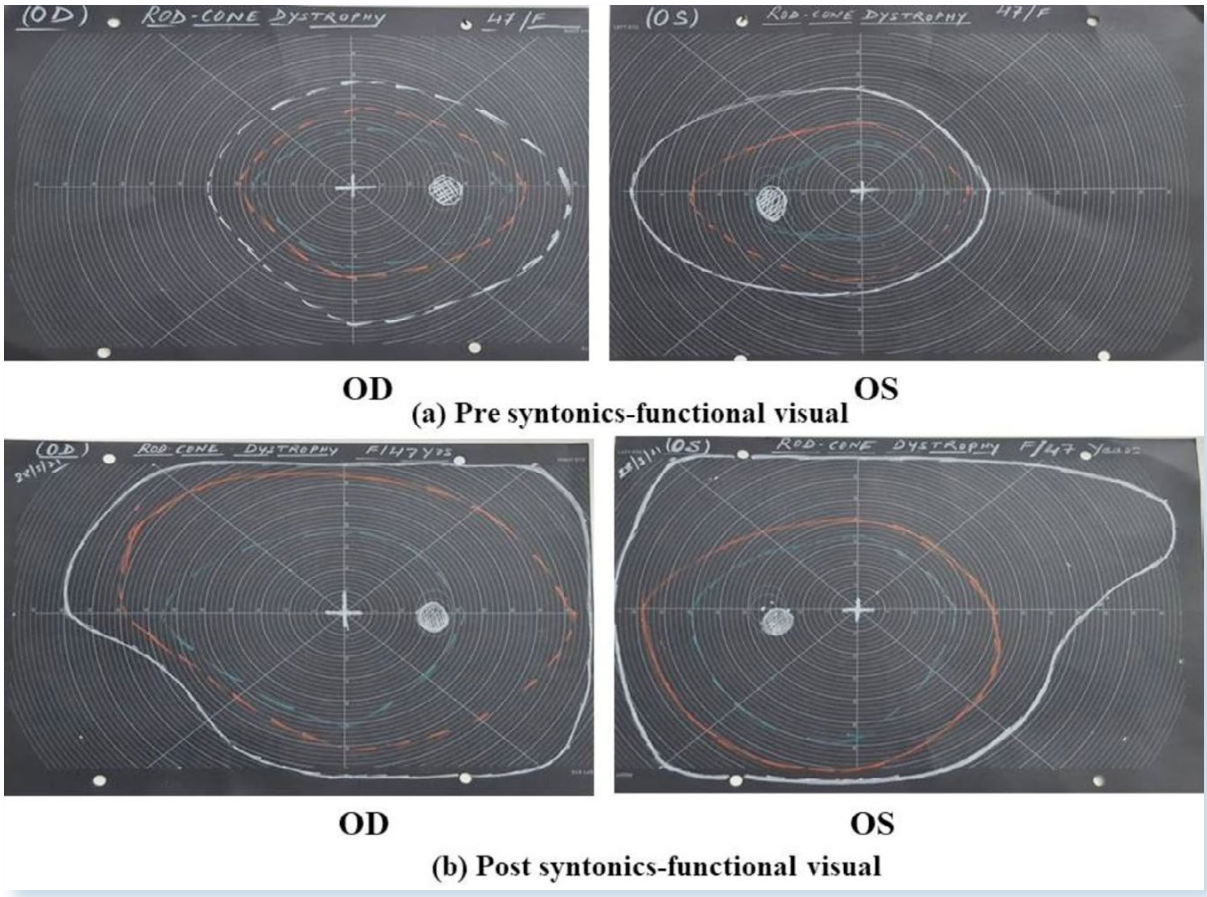

Figure 5. Functional Visual Field (OD/OS) pre and post syntonic phototherapy treatment (a) Pretreatment functional visual field (b) Post treatment functional visual field

Diagnosis / Findings:

- Severe Rod- Cone Dystrophy (OD/OS)
- Reduced Visual Field (OD/OS)

Management Plan and Prognosis

The primary objective of vision therapy was to improve the patient's visual acuity in both eyes with a secondary goal to improve the visual field in both the eyes. Hence, the change of her earlier eye glasses prescription to a bifocal prescription was recommended with OD +1.50 DSPH, OS +2.50/ -0.50 X 90, ADD: +2.00 DSPH OU. The patient was simultaneously advised to proceed with syntonic phototherapy in combination with vision therapy in order to improve expand the constricted visual field in both eyes and to improve her visual abilities to the maximum potential. The patient was completely educated regarding the treatment plan in minute detail and the potential for visual field expansion and enhancement of visual abilities in both eyes. After obtaining the patient's informed consent, treatment procedures were started according to our standard treatment plan.

Treatment

The entire treatment plan was based on three important objectives required for the patient in the order of significance which included expansion of visual field followed by the enhancement of visual ability concomitantly with ocular motility improvement.

The treatment plan was initiated with in-office vision therapy sessions for 5 days per week. In-office vision therapy was administered for an hour per day with twenty minutes of Syntonic Phototherapy using the filter combinations of Alpha-Delta for ten minutes followed by Mu-Delta for 10 minutes with a gap of 5 minutes between the filter combinations. The patient was instructed to keep her eyes closed during the 5-minute gap as illustrated in the Figure 6.

Alpha-delta and mu-delta filters were chosen based on the principles of syntonic syndromes (chronic syndrome + lazy eye syndrome).

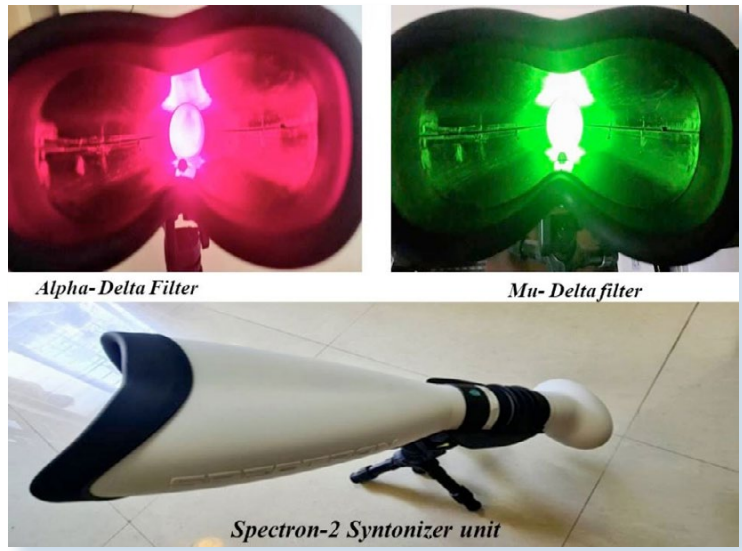

Figure 6. Syntonic Phototherapy filters with the Spectron-2 Syntonizer unit.

According to the lazy eye syndrome, Alpha-Delta (red to orange) acts as a strong sympathetic stimulant to treat esotropia or amblyopia. The filter combination applied in the procedures is thought to construct a higher electrical charge in the cell membranes to reduce the synaptic resistance and thereby overcome amblyopia and binocular suppressions. Diagnosis may also include functional visual field constriction, abnormal retinal correspondence, and poor fusion.

With respect to the chronic syndrome, individuals with chronic or degenerative health problems may have a history of organic, metabolic or toxic exposure or may have experienced past trauma. The filter combination consisting of Mu-Delta (lemon) is commonly employed as a physiological stabilizer and detoxifier. Symptoms may include fatigue, loss of visual stamina, asthenopia, headaches, photophobia, and transient blur. Diagnostic findings include constriction of the visual fields, esophoria, low recoveries in ductions, accommodative insufficiency, reduced red or green fields, and blue field constriction in the case of liver involvement. Alpha-Delta (red-orange) followed by Mu-Delta (lemon) is also 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.

The remaining 30 minutes after her Syntonic treatment was a combination of monocular oculomotor therapies to stabilize and address her oculomotor deficits utilizing the Sanet Vision Integrator (SVI) saccades module, SVI Rotator Module, Hart chart, Space Fixator, SVI Saccadic Fixator, and with Marsden Ball and the Pegboard rotator together. Different modules of peripheral charts on SVI were combined in the later stages of therapy to strengthen the patient's peripheral awareness. A therapy procedure performed with the swinging Marsden Ball is combined with walking to improve her peripheral awareness while reading a Hart Chart at distance and instructed to be highly aware and open to her periphery so that the Marsden ball should not hit her. Later a metronome is added with the above mention therapy techniques to improve her speed and automaticity. The activities of peripheral awareness training with Marsden Ball, peripheral charts on SVI, and fixator board performed by the patients are illustrated in the Figure 7.

Once the patient showed initial improvement in speed and accuracy with her eye movements, the treatment plan was moved to the next level with the objective of reducing the target size on each activity of oculomotor training

Figure 7. Peripheral awareness training performed by the patient.

Table 2: In-office based vision therapy activities.

OculomotorTherapies	Perihpheral Awareness	Syntonics Phototherapy
Pursuits – Peg Board Rotator, Marsden Ball, Rotational Hart Chart, Rotator Module on SVI	Marsden Ball with Hart Chart Reading and Walking	Alpha – Delta 10 Mins/ Day *Followed By* Mu- Delta 10 Mins/Day
Saccades - 4 Corner Saccadic Chart, SVI Saccades Module	Space Fixator	
SVI Eye Hand Coordination Module	SVI Peripheral Charts Module	

to accomplish more precise and accurate oculomotor control. In the later stages, binocular eye movement training was also performed during each therapy procedure, the SVI peripheral chart target size was reduced with full use of the expanse of the 50" SVI screen. Table 2 provides the in- office based vision therapy activities.

Progress Evaluation

After the execution of her treatment plan and at the end of sixty sessions of in-office Syntonic and vision therapy (5 sessions per week x 12 weeks), the patient was sent for repeat ERG testing to assess for any change in rod or cone cell function. The repeat f-FERG revealed the following results:

Dark adapted scotopic response

The implicit time of 'b' wave was normal in the right eye but found to be delayed in the left eye. Similarly, the amplitude of 'b' wave was normal in the right eye, while there was a gross reduction of the same in the left eye.

Dark adapted combined response

The 'a' wave implicit time was delayed in both eyes. The 'a' wave amplitude was normal in the right eye but grossly reduced in the left eye.

The 'b' wave implicit time was delayed in both eyes, while the amplitude of 'b' wave was mildly reduced in the right eye and grossly reduced in the left eye.

Oscillatory potential response

There was a mild reduction in OPs in the right eye, while it was moderately reduced in the left eye.

Light adapted cone response

The implicit time and the amplitude of 'a' wave was normal in the right eye, while the left eye showed a grossly reduced values of the same. The 'b' wave implicit time was normal in both eyes, while both eyes revealed a reduction in 'b' wave amplitude

30HZ Flicker Response

Flicker response was normal in both eyes.

Impression

Rod-Cone degeneration in the left eye. Early retinal function loss observed in the right eye.

Final Outcome

After 12 weeks comprised of sixty sessions of in-office syntonic phototherapy and vision therapy sessions, a final progress evaluation was conducted. At distance, best corrected visual acuity in both eyes improved from 6/24 to 6/12 at distance and from N12 to N6 at near. The Alpha Omega pupil assessment improved from grade 4 to grade 1. The SCCO oculomotor test inclusive of both saccades and pursuits were now normalised in her right eye and left eye and her functional visual field expanded up to normal ranges which were earlier reported to be reduced by 45% as shown in the Figure 3 (a) and (b). Her repeat f-FERG testing revealed only early retinal function losses which was previously reported as severe RCD and left eye RCD with mild improvement noted in the ERG values as

Table 3: Pre and post treatment fFERG result for Case 1.

Comparison of pre and post treatment f-FERG Data	
Before Therapy (Syntonics + VT) in May 2015 ERG Data	**After Therapy (Syntonics + VT) in June – 2021 (60 sessions) ERG Data**
1) Dark Adapted Scotopic Response: -Extinguished wave pattern detected & hence not marked	**1) Dark Adapted Scotopic Response:** -the implicit time of B-wave is normal in OD and delayed in OS, the amplitude of B-wave is normal in the OD & gross reduction in OS.
2) Dark Adapted Combined Response: -A - wave implicit time was delayed in both the eyes i.e., 26.5 ms & 24 ms respectively. -B – wave implicit time was delayed in both the eyes i.e., 48.5 ms & 46.5 ms respectively. -A - wave amplitude is reduced in OD -130.7 uv & in OS -127 uv. -B - wave amplitude is reduced in OD 113.9uv and OS 122.6 uv.	**2) Dark Adapted Combined Response:** -A-wave implicit time is delayed in both the eyes but faster than last time i.e., 18.5ms & 22.3 ms respectively. -B-wave implicit time is delayed in both the eyes i.e., 50.1 ms & 46.6 ms respectively. -A- wave amplitude is normal in OD 143.42uv and grossly reduced in OS 59 uv. -B – wave amplitude is mildly reduced in OD 229.21 uv and grossly reduced in the OS 115.81
3) Oscillatory Potential Response: -there is a gross reduction in amplitude of OP in both the eyes. (OD/OS)	**3) Oscillatory Potential Response:** -there is very mild reduction in amplitude of OP in OD and moderate reduction in amplitude of OP in OS.
4) Light adapted Cone Response: -A-wave implicit time was normal in both the eyes i.e., 19 ms & 16.5 ms respectively. -B – wave implicit time was delayed in both the eyes i.e., 37 ms & 42 ms respectively. -A- wave amplitude is reduced in OD -15.4 uv & in OS -30 uv. -B-wave amplitude is Grossly reduced in OD 31.4 uv and OS 11.8 uv.	**4) Light Adapted Cone Response:** -A-wave implicit time is normal in both the eyes i.e., 16.1 ms & 20.2 ms respectively. -B-wave implicit time is normal in both the eyes i.e., 31.6 ms & 32.1 ms respectively. -A- wave amplitude is normal in OD 39.54 uv and grossly reduced but much better than last time i.e., OS 3.21 uv. -B – wave amplitude is mildly reduced in both the eyes but much better than last time i.e., OD 42.82 uv & OS 31.29 uv
5) 30 Hz Flicker Test: 30Hz flicker response showing reduced amplitudes in both the eyes with normal implicit time in both the eyes.	**5) 30 Hz Flicker test:** -30 Hz flicker response shows normal Amplitudes in both the eyes with normal implicit time in both the eyes.
IMPRESSION: -Severe Rod- Cone dystrophy in both the eyes. (OD/OS)	**IMPRESSION:** -Only early retinal function loss in OD. (*condition reversed in OD) -Rod- Cone dystrophy in OS with small improvement NOTED as compare to past ERG test.

compared to her ERG of 2015 as depicted in the Figure 2 (a) and (b). She reported better recognition and awareness in peripheral vision along with better visual acuity and visual abilities in both eyes. Table 1 provides an overview of her testing pre & post therapies. She was instructed to continue in-office therapy with the maintenance protocol of 1 session per week for the next 1 month with the same office therapy procedures as mentioned above, and then periodic follow -up was done after 3 months, 6 months and 1 year. The summary of f-FERG before and after treatment is enlisted in Table 3.

CASE 2

An eleven years old boy presented at Caring Vision Therapy Centre at Chennai, with a diagnosis of RCD. He complained of progressive vision loss, photophobia and falling short in school performance. His major complaints were blurred vision in both eyes and impaired night vision since 3 years of age. As per the patient's birth history, he was a full term baby with Lower Segment Caesarean Section (LSCS) and his birth weight was normal. The patient's parents observed him to have difficulty seeing at age of 2 years for which they consulted eye

hospital. He was diagnosed as having myopia and he was prescribed eyeglasses of Rx OD: -4.50/ -1.00 X 10 & OS: -4.50/ -0.75 X 10. At the age of around 3 years, his parents noticed some difficulty with night vision. They consulted a tertiary eye hospital, where he had undergone ERG test under general anesthesia. His ERG test revealed non-recordable rod and cone response and hence he was diagnosed with RCD. Genetic analysis was not done. His parents had a consanguineous marriage but no other family member has any genetic disorder. Once the diagnosis of RCD was established, his parents took him to the ayurvedic hospital where he was treated with ayurvedic medication. There was no considerable improvement observed in the patient's vision status. Thereafter, patient visited us for further consultation.

His eyeglasses prescription was OD -4.50/ -1.00 X 10 and OS - 4.50/ -0.75 X 10. The patient's visual acuity with his eyeglasses was 6/60 in both eyes. Near visual acuity was N24 in both eyes.

The clinical examinations information is enlisted in Table 4. On clinical examination, his subjective refraction was found to be OD: -6.00/ -2.75 X 10, OS: -4.75 / -2.50 X 10.

Visual acuity with the new prescription was 6/60, N24 for distance and near respectively in both eyes. No considerable change was observed in the visual acuity but, he was advised to use the new eyeglasses prescription. EOMs were found to be full and unrestricted. Random Dot Stereopsis was identified to be absent. Pupil reactions to light was brisk and RRTL on both eyes. SCCO oculomotor test performance was reduced for saccades and pursuits. Anterior segment evaluation was within normal within limits. Alpha-Omega pupil assessment was Grade three. Ophthalmoscopic fundus investigation marked the similar findings of macular and foveal atrophy along with the presence of thickened blood vessels involving both eyes and suggestive of cone dystrophy. The functional visual field was found to be highly constricted and reduced by 65% reduced in each eye as documented in the Figure 8(a).

Table 4: Comparison of diagnostic data pre and post syntonic phototherapy and vision therapy treatment – Case 1

Diagnostic Data		
Clinical Test	**Pre-Therapy**	**Post-Therapy**
Spectacle Rx	OD: -4.50/ -1.00 X 10	
	OS: +4.50/ -0.75 X 10	
Visual Acuities		
OD(Dist., Near)	6/60, N24 (Unaided)	6/24 P, N12 (Aided)
OS(Dist., Near)	6/60, N24 (Unaided)	6/24 P, N12 (Aided)
EOM		
OD	Full	Full
OS	Full	Full
Final Acceptance		
OD		-6.00/ -2.75 X 10
OS		-4.75 / -2.50 X 10
Pupil		
OD	BRISK, RRTL	BRISK, RRTL
OS	BRISK, RRTL	BRISK, RRTL
IOP		
OD	13.00 mm of Hg	14.00 mm of Hg
OS	14.00 mm of Hg	
Oculomotor		
SCCO (fixation) SCCO (Pursuits) SCCO (Saccades) Score 3^+- 4^+= Pass 1^+- 2^+= Fail	2^+, 1^+, 3^+ (OD, OS, OU) 1^+, 1^+, 2^+ 2^+, 1^+, 2^+	4^+, 4^+, 4^+ 4^+, 4^+, 4^+ 4^+, 4^+, 4^+
Anterior Segment	All normal	All normal
Alpha – Delta pupil assessment	Grade 4 (OD/OS)	Grade 1 (OD/OS)
Direct Ophthalmoscopy (Fundus Exam) OD	Macula/Foveal Reflex: Atrophy, Remarks: Cone Dystrophy, blood vessels thinning	
OS	Macula/Foveal Reflex: Atrophy, Remarks: Cone Dystrophy, blood vessels thinning	
Functional Visual Field Test (Spectron Visual Field Charter)		
OD	Reduced by 65%	Enlarged & Normal
OS	Reduced by 60%	Enlarged & Normal

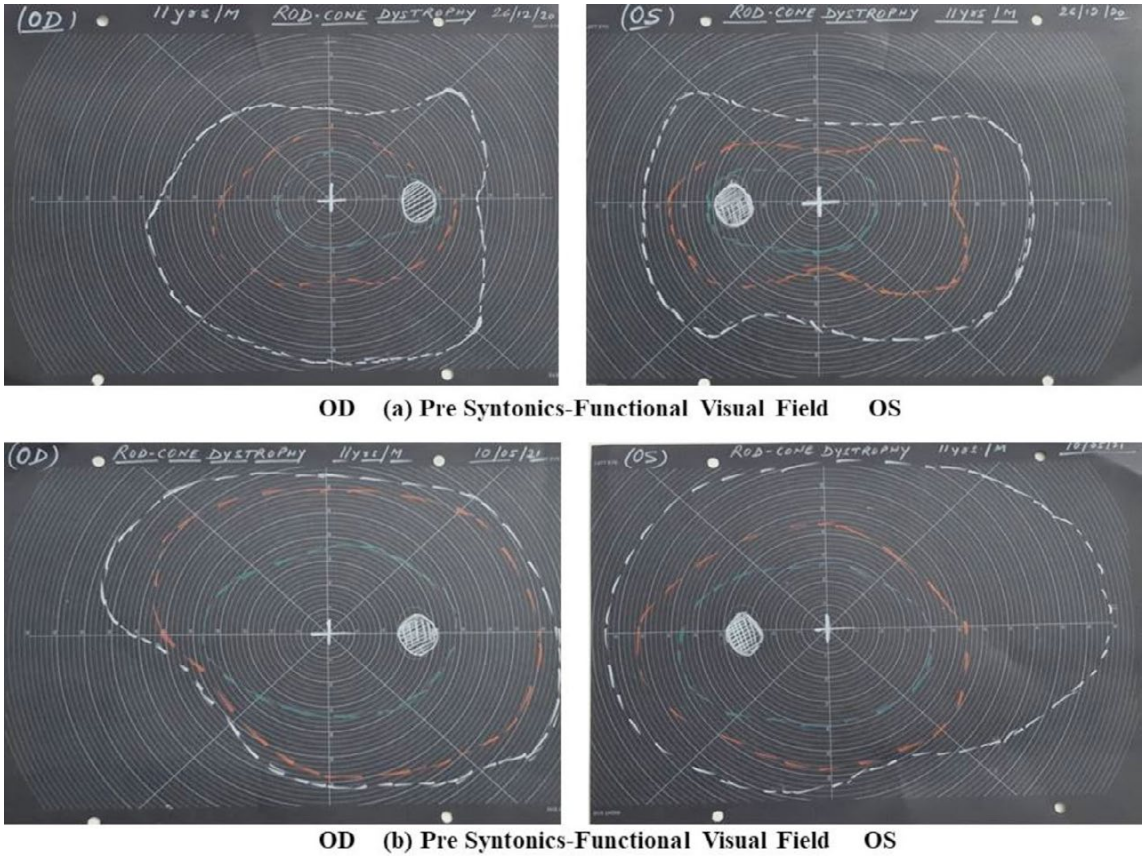

Figure 8. Functional Visual Field (OD/OS) pre- and post-syntonic phototherapy treatment (a) Pre-treatment functional visual field (b) post-treatment functional visual field, Case -2.

Diagnosis / Findings

- Severe Rod- Cone Dystrophy (OD/OS)
- Reduced Visual Field (OD/OS)

Prognosis

The patient's main goal for vision therapy was to improve the vision in both eyes and his secondary goal was to improve the visual field in each eye. We recommended he change his eyeglasses prescription to the new prescription of OD: -6.00/ -2.75 X 10, and OS: -4.75/ -2.50 X 10. The treatment plan of syntonic phototherapy in combination with vision therapy to expand the constricted Visual field for each eye and to improve his visual abilities was recommended. We gave a guarded prognosis about his visual condition and thoroughly explained the entire treatment process to his parents. The treatment was started once the parents and the patient accepted the guarded prognosis and agreed with the treatment plan.

Treatment

The entire treatment plan was based on three important objectives required for the patient in the order of significance which included expansion of visual field followed by the enhancement of visual ability concomitantly with ocular motility improvement.

The treatment was introduced with 5 days per week of in-office vision therapy sessions. In-office vision therapy was directed for one hour a day with twenty minutes of syntonic phototherapy by the filter combinations of Alpha-Delta for ten minutes followed by Mu- Delta for ten minutes with a gap of five minutes between the uses of the filter combinations. The patient was asked to keep his eyes closed in that gap of five minutes. The remaining 30 minutes after his Syntonic treatment was a combination of monocular oculomotor therapies to stabilize and address his oculomotor deficits utilizing the Sanet Vision Integrator(SVI) saccades module, SVI Rotator Module, Hart chart, Space Fixator, SVI Saccadic Fixator, and with Marsden Ball and the Pegboard rotator together. Different modules of peripheral charts on SVI were combined in the later stages of therapy to strengthen the patient's peripheral awareness. A therapy procedure performed with the swinging Marsden

Ball is combined with walking to improve his peripheral awareness while reading a Hart Chart at distance and instructed to be highly aware and open to his periphery so that the Marsden ball should not hit him. Later a metronome is added with the above mention therapy techniques to improve her speed and automaticity.

Once the patient showed initial improvement in speed and accuracy with his eye movements, the treatment plan was moved to the next level with the objective of reducing the target size on each activity of oculomotor training to accomplish more precise and accurate oculomotor control. In the advanced stages, binocular eye movement training was also performed during each therapy procedure, and the SVI peripheral chart target size was reduced with full use of the expanse of the 50" SVI screen. Table 2 provides the in- office based vision therapy activities.

Progress Evaluation

After 60 sessions of in-office Syntonic Phototherapy and Vision Therapy, a progress evaluation was scheduled. His visual acuity in each eye improved to 6/24 from 6/60 and his functional visual field expanded in each eye. He was advised to have repeat ERG testing but due to increasing COVID-19 cases and intense lockdown, this particular patient relocated to their native place and hence was not available for repeat ERG and follow-up.

Final Outcome

After 12 weeks (60 sessions) of in-office syntonic phototherapy and vision therapy sessions a final progress evaluation was conducted. At distance, best corrected visual acuity OD and OS improved from 6/60 to 6/24 and at near it improved from N24 to N12 in each eye. Alpha Omega pupil assessment improved from grade 3 to grade 1. The SCCO oculomotor test (saccades and pursuits) now normalised in each eye and his functional visual field expanded up to normal ranges which were initially reduced by 65% as documented in Figure 3(a) and (b). He was not available for repeat f-FERG testing. He reported improved better recognition and improved awareness in his peripheral vision, and improved visual abilities in both eyes with more comfort during evenings and night vision. Table 3 provides an overview of his testing between the pre and post therapy treatment. He was instructed to continue his in-office therapies with the maintenance protocol of 1 session every week for the next 1 month then periodic follow-up after 3 months, 6 months and 1 yr.

DISCUSSION

IRDs comprise an enormous group of genetically and clinically mixed disorders affecting the photoreceptor function and constitute the leading cause of legal blindness across the globe. It primarily affects the adults and then childhood candidates.[14] Among the IRD subgroups, progressive cone dystrophies and CRD are caused by the degeneration of cone receptors later followed by the rod receptors. Their calculated incidence is about 1 in 20000 to 100000.[1,15] The incidence of RCD is not known. A recent study on IRD by Dhoble Py et al conducted a survey on 601 South Indian patients over a period of 3 years with an objective to characterize the clinical manifestation and prevalence of IRD and its subset.[13] Male gender was the predominantly affected population and only 8% of the population was less than 10 years of age. The study inferred that the majority of the affected population had the diagnosis of RP (46%) inclusive of decreased ERG rod function and fundus changes whereas Cone Dystrophy (COD) and CRD accounted for 12% of the cases. This indicated a rising trend in the spectrum of RP when inclusive of RCD. The clinical importance for the diagnosis of RCD should be provided due to its rising trend in the incidence status and availability of different treatment modalities such as syntonic and vision therapy.

RCD is considered as the rare congenital retinal degeneration. Diagnosis of the pathology should be made properly but usually it is very

difficult as it contains a broad spectrum of clinical features and could be mistaken for other medical conditions. In our case series, case 1 presented with a diminution in night vision and the case 2 patient complained of progressive vision loss along with impaired night vision which directly corresponds to rod function more than the cone dysfunction. Norden et al. has illustrated the way by which an optometrist could effectively manage RCD or CRD.[17] Diagnosing the exact pigmentary dysfunction of whether RCD or CRD is important for potentially preventing further deterioration and reducing the patient's dependency due to visual acuity and visual field changes both of which may be treated with syntonic phototherapy and vision therapy as demonstrated by our case series.

Kuehlewein et al.[18] documented the first report on RCD associated with Williams syndrome in a 14-year-old Asian Indian girl with the ophthalmic investigational characteristic of slit-lamp biomicroscopy, ophthalmoscopy, optical coherence tomography, fundus autofluorescence imaging, full-field electroretinography, and multifocal electroretinography reliable with panretinal RCD in the background of genetically confirmed Williams-Beuren syndrome (chromosome 7). Like the previous report, our patients have also been through all the ophthalmic investigation coherent with the findings of RCD.

To our knowledge, this is the first case series demonstrating the benefits of applying syntonic phototherapy combined with vision therapy for enhancing visual acuity, visual field, oculomotor motility, and other visual abilities in patients with RCD. Similarly, our previous case report had demarcated the clinical enhancement of vision abilities, visual acuity, vision field expansion and oculomotor ability through synchronous approach of syntonic phototherapy and vision therapy in form deprivation amblyopia and strabismus patients.[13]

Syntonic phototherapy has already been applied in patients who had deficiencies of visual acuity, oculomotor skill, binocularity, accommodative facility and constricted functional visual field. Our RCD case series patients had functional visual field constriction and syntonic phototherapy combined with vision therapy expanded the visual field extensively. Visual field expansion has aided the normal binocular vision. It is well known that light has the potential to stimulate the skin and eyes which in turn triggers the photosensitive elements in the blood vessels and photosensitive regions in the brain through retinal vascular beds and rods and cones through optic nerve.[19] Studies also proved the benefits of syntonic phototherapy for disabled children in terms of visual field and academic performance.[15] Autonomic nervous system imbalances may lead to binocular and accommodative disorder and in turn light frequencies were used to balance the autonomic nervous system.[20]

The current series showed promising results with the combined approach of syntonic phototherapy and vision therapy in RCD patients and has encouraged vision centers like us to deal with other similar pathology like RCD with proper scientific background and a treatment approach based on the patient's present status.

CONCLUSION

The current case series has demonstrated that the clinical approach of syntonic phototherapy combined with vision therapy could aid in restoring vision acuity, visual field and oculomotor abilities in RCD patients. Further studies are therefore recommended on a larger number of RCD patients to explore the benefits of syntonic phototherapy and vision therapy as a treatment for preserving vision of patients with RCD.

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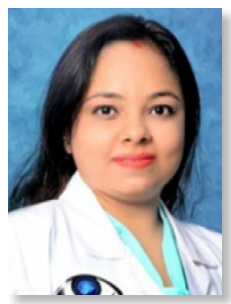

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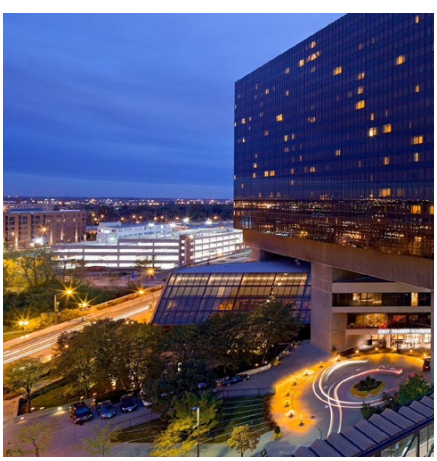
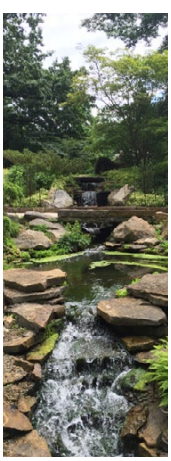


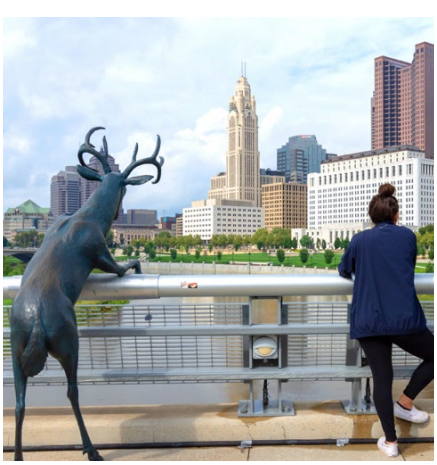
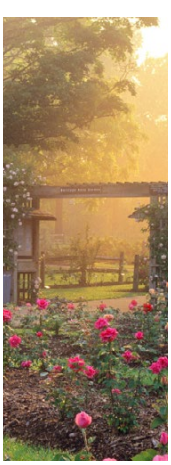


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