

# Role of Prism Relocation in Improving Visual Performance of Patients with Macular Dysfunction

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## ABSTRACT

**Patients with macular dysfunction were given spectacle lenses with prism and a control group of similar patients were assessed without prism. About 60% of those without prisms learned to improve acuity by eccentric viewing. Over 90% of those fitted with prisms showed an improvement in acuity and performed better on locomotion tests.**

**Key Words:** age-related macular degeneration, low vision, prisms, locomotion, eccentric viewing

The ability to discriminate fine detail depends on the integrity of the macula, and age-related macular disease is the leading cause of uncorrectable vision loss in individuals aged 65 years and older. Although there are medical or surgical interventions that can influence the progress of this disease, once loss of function has been sustained it cannot be reversed. However, there are several methods of compensating for macular vision loss: (1) magnification with microscopes or telescopes to enable resolution of smaller images of objects using portions of the retina not ordinarily capable of fine resolution; (2) use of large print materials for the same purpose; and (3) training the patient to use eccentric viewing (functionally creating a new "central" area), thereby taking the scotoma out of direct gaze. This does not restore the high resolution of a

healthy macula but optimizes visual acuity on the best remaining healthy portion of the retina.

In 1982, Romayananda et al.<sup>1</sup> published the results of treating 59 patients with "prism scanning," a method of relocating images on the retina using prisms in addition to customary refraction techniques. She claimed 100% success. Coincidentally, several articles appeared in Northwestern New York newspapers reporting significant functional improvement in low vision patients treated with prisms provided according to the method of Onyufrik,<sup>2</sup> who also claimed success in improving visual function and was demonstrating his diagnostic device at medical meetings and at seminars for optometrists and ophthalmologists.

Mixed success rates with the method of prism relocation have been reported by independent clinicians and clinicians.<sup>a</sup> The present study was undertaken as a controlled clinical trial to assess the efficacy of prism relocation of images when treating patients with macular dysfunction.

## METHODS

Subjects for the trial were recruited in the Low Vision Clinic at The New York Lighthouse according to the criteria listed in Table 1. After the customary low vision evaluation, appropriate patients were informed of the details of the study and, if they were willing to participate, were formally asked to give "informed consent."

Subjects were then evaluated for prism correction by a clinical investigator according to the criteria in Table 2. Those demonstrating improvement on the acuity task or in clinical impression then had a prism prescription written and were fitted by the ophthalmic dispenser with appropriate frames.

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**TABLE 1.** Criteria for participation in prism relocation study.

Subjects:

1. Were over the age of 22 years.
2. Had been referred to the Low Vision Service at The New York Association for the Blind.
3. Had a confirmed diagnosis of macular disorder.
4. Had impaired central visual acuity confirmed on evaluation at The Lighthouse.
5. Completed a low vision evaluation at The Lighthouse.
6. Agreed to participate in the study although it might delay the most efficacious treatment for their condition. Subjects were excluded from this study if a significant new refractive correction was prescribed to improve distance acuity before prism evaluation. Subjects for whom headborne telescopes were prescribed agreed to defer the filling of this prescription until after the completion of the prism study.

**TABLE 2.** Criteria for prescribing a prism correction.

1. Objective improvement in chart-measured visual acuity.
2. Subject reports a functional improvement in vision such as objects are darker, sharper, have improved contrast, or that he/she had better mobility.

### Protocol for Determination of Specifications of Prism Glasses

*Visit A.* At each visit medical and ocular history were updated. Distance visual acuity was measured with each eye without correction and with best correction, using printed optotypes on Lighthouse Visual Acuity Charts available as LHDV 8A and 8B charts in the Lighthouse Catalog of Optical Aids. Acuity was recorded at 10 ft unless the subject saw less than 10/200 (6/120), in which case the 5-ft distance was used.

*Distance Correction Determination.* The subject's best correction was placed in a trial frame. If cylinder was less than or equal to  $-2.50$  D spherical equivalent was used in order to reduce the number of lenses in the frame. If cylinder power was greater than  $-2.50$  D full astigmatic correction was used.

The better seeing eye was tested first. The subject was asked to turn the eyes or head in the direction of best vision. This was done as the subject fixated a target easily seen while looking straight at it. As a starting point, an arbitrary  $8 \Delta$  prism was then placed in the trial frame, base in the direction of the head-turn, and apex in the direction of the eye-turn. If there was no response to head or eye turn, the subject was asked to rotate the prism by turning the axis dial on the trial frame to the position of clearest vision. A rotary prism was placed at this axis and optimum prism power was determined, using a bracketing technique. The eye was then refracted through the prism and the procedure was repeated for the poorer seeing eye, using a target easily seen by that eye.

The subject's visual acuity and impression were recorded by letter chart and by comparison with the habitual correction by asking if the prism cor-

rection was worse than, the same as, or better than their own best glasses. The answer was qualified by the statements, "much worse" vs. "somewhat worse," or "much better" vs. "somewhat better."

The correction was refined binocularly by having the subject rotate the prism axis on the poorer seeing eye to the position of maximum binocular comfort with single vision, and the subject's visual acuity and impression were again recorded according to the method described above.

*Intermediate Correction Determination.* If there was a demand for vision at a specific intermediate distance (relating to tasks such as television, CRT screens, or music, for example) the procedure was repeated for the appropriate distance. Prism glasses were prescribed for the particular task and the subject's impressions were recorded as above.

*Near Correction Determination.* Near acuity was recorded at an appropriate distance with the habitual add in place using LHNV-1 chart (near optotypes as described in the Lighthouse Optical Aids Catalog). The near prism correction was determined by placing the prism correction for distance in the trial frame. Trials of acuity with and without prism using appropriate adds were recorded. Clinical judgment was used to determine the amount of add, considering the working distance and subject performance. The amount of prism and axis were refined, and a final near acuity was recorded using LHNV-1 chart and continuous text test chart NVCT-1 available as above. The subject's impressions were recorded as a comparison to previous reading glasses.

To conclude this visit, an exit acuity was recorded without correction, with best correction, and with the prism correction. The subject was then transferred for visual fields, pupil dilation, fundus photography, facial measurement, and frame selection.

*Visit B—Dispensing Prism Correction.* Additional health/eye information was obtained. Entrance acuity was recorded at distance and near, uncorrected, and best corrected. The charts used were LHDV 8A and 8B for distance, and LHNV-1 for near.

The optician dispensed distance, near, and intermediate glasses. Acuity was recorded with each pair of glasses using the appropriate chart and working distance. The subject's impressions were then recorded.

The subject was then accompanied as he or she walked around while wearing the prism correction. Subjects were instructed to wear the new glasses indoors for short periods of time, building up time gradually, depending upon tolerance levels. [New prism glasses may cause nausea.] It was explained that prisms sometimes distorted distances, causing curbs and steps to present a particular hazard. Subjects were instructed not to go outdoors unaccompanied while wearing the prism correction until the glasses felt comfortable and distances appeared perfectly natural. Each subject was asked to report experiences with the new glasses at the next visit. Near vision glasses were to be compared with ha-

bitually used near glasses, whether conventional lenses or low vision aids. An appointment was made for the 6-week follow-up.

*Visit C—6 Weeks Later.* Updated health/eye information was requested. The subject's acuity and subjective responses were recorded without correction, with best correction, and with prism correction. Visual fields and fundus photography were performed.

*Visit D—3 Months Later.* The subject's acuity and subjective responses were recorded. If subject was a "control" and did not receive prism glasses, a prescription was determined for prism glasses at this time. If the subject was in the "treatment" group an exit interview was conducted.

*Visit D—Dispensing Prism to Former "Controls."* The subject's acuity and subjective responses were recorded and instruction in the use of glasses was presented. An exit interview was conducted. Where the project schedule permitted, these subjects were seen 3 months later and treated as treatment subjects and their data appropriately entered into the project data bank.

### **Method of Selection of Treatment and Control Subjects**

After the first visit for prism evaluation (Visit A), subjects deemed suitable candidates for use of prism glasses (see Table 2) were randomly assigned to treatment or control groups by one of the principal investigators according to their Lighthouse case number that had been assigned at intake by Lighthouse administration staff in random fashion. The property of "odd" or "even" case number was used to determine the subject's status as treatment or control in the study, thus preventing bias according to examiner preference or subject pressure or other nonrandom factors.

The results as summarized below were the results of examination and interview after approximately 3 months of trial with the prescribed glasses for both treatment and control subjects. The control group subjects were evaluated on the same schedule and according to the same protocol as the treatment group except that the glasses prescribed for these subjects (and worn for the 3 month period) were designed to resemble the prism glasses by weight, average thickness, and appearance as closely as possible but contained no prismatic component.

### **Protocol for Visual Fields and Fundus Photographs for Prism Study**

After initial prism evaluation, visual fields evaluation and fundus photography were performed to determine what area of the retina was being utilized for fixation, and to estimate the size of the scotoma created by the retinal pathology. In a few cases, fundus photographs had to be deferred due to problems with the equipment, or were not performed either at the subject's request or because of a condition which prevented pupil dilation.

A detailed analysis of the central visual field was performed first, utilizing a standard black tangent screen with a large white "X" across the surface to help subjects identify the fixation target more easily. The fields were first mapped with a 5/1000 white target, unless scotomata could not be elicited with the target. In that case, the target size was reduced to 3/1000 white to increase the sensitivity of the test. Subjects with distance spectacles were tested through these corrections unless the subject reported greater clarity on the screen without the glasses.

Each subject received the following instructions from the examiner:

"Find the center of the X; then hold your eye on the center for the rest of the test. A small ball will be moving across the surface of the screen. Do not look around for the ball. Continue to hold your eye on the center of the X. As soon as you see the ball, let me know."

Scotomata were first detected by combing the screen. They were then plotted from nonseeing to seeing. Several plotted points were checked more than once to get some estimate of stability of fixation and reliability of responses. Observations concerning stability of fixation, eye turns, and head turns were recorded on the examination form.

After central visual field evaluation, biomicroscopic examination of the anterior segment was performed to determine the presence of media opacities and to evaluate the depth of the anterior chamber angle before dilation. On rare occasion, gonioscopic evaluation of the angle was performed with a Goldmann 3-mirror lens. Goldmann applanation tonometry was performed on each eye, and 1 drop of 1% Tropicamide was instilled in each eye if there were no contraindications.

Before onset of mydriasis, the peripheral field was evaluated with a Goldmann Hemispheric Perimeter. All peripheral testing was done with a III4e target, and subjects were instructed to fixate on the central fixation target in the instrument. If they were unable to locate the fixation target because of a large central scotoma, they were instructed to hole their eye "as straight as possible." Evaluation of the central field was also performed with the Goldmann Perimeter for comparison with the results on the tangent screen. Central testing was performed with a III4e target unless the central defects could not be elicited with this target, in which case central testing was repeated with a I4e target.

After this second field evaluation, subjects were checked for mydriasis. If necessary, a second drop of 1% Tropicamide was instilled.

Once sufficient dilation was obtained, fundus photography was performed with a Topcon model TRC-JE Fundus Camera with Kodachrome "25" 35-mm film. Flash intensity was set at either 75 Ws or 100 Ws, depending on the clarity of the ocular media. Background illumination was kept at the lowest possible level that would still allow proper focusing of the image.

**TABLE 3. Results.\***

Description	Treatment	Control
	No. (%)	No. (%)
Improvement in visual acuity and function	9 (43%)	2 (18%)
Improvement in function only	7 (38%)	4 (36%)
Improvement in visual acuity only	2 (10%)	1 (8%)
No change in visual acuity or function	1 (5%)	4 (36%)

\* The differences between groups is significant at the 0.06 level by the  $\chi^2$  test,  $df = 3$ .

In an attempt to determine locus of fixation, the fundus camera was equipped with an internal pointer. Subjects were instructed to locate the tip of the pointer inside the camera and to keep looking directly at the tip. If the subject could not see the pointer, photographs were still taken with the subject fixating the external pointer with the other eye in order to document the appearance of the lesion.

A total of 3 or 4 photographs was taken of each eye, depending on the clarity of the ocular media. A minimum interval of 30 s between pictures was used to help reduce the bleaching effect of the flash. The first 2 pictures in each eye were taken with the internal pointer approximately in the same location. For the 3rd picture (and the 4th, when done), the pointer was moved a significant distance from the first location to see if the subject would follow it and fixate it with the same area of the retina.

After the 3rd prism visit, fields and fundus photography were repeated using these same procedures with the addition that the tangent screen fields were performed both with and without the distance correction which the subject received in the prism study. Subjects were generally tested with the spectacle correction first.

## CONCLUSIONS

The results of this study (Table 3) indicate that there is sufficient evidence, based on comparison of visual acuity and functional reports from subjects, to suggest that: (1) prism relocation of images may be a valid approach to the functional improvement of visual performance in macular dysfunction as measured on the Lighthouse Acuity Chart (LH#DV8A,B) and by subjective impressions of subjects; (2) prism correction should be prescribed where indicated only after an adequate trial period to confirm efficacy with individual subjects; and (3) further studies are necessary.

## DISCUSSION

Prism relocation has been rejected *a priori* by some clinicians because, they claim, the same "relocation" of images should be accomplished by eccentric viewing with or without small head turns

without prisms. Our clinical experience indicates that many patients with macular dysfunction do, in fact, accomplish this task without assistance. In this study, 60% of the control group did improve in visual acuity, general performance, or both with proper refraction and no prism correction although they had an immediate positive result during the examination with prisms. On the other hand, 91% of the treatment group improved, yielding a measure of significance at the 0.06 level. With a weak level of significance of the difference between treatment and control groups, one should seek theoretical support for any conclusions.

Greene,<sup>3</sup> Turvey and associates,<sup>4</sup> and Schlag and Schlag-Rey<sup>5</sup> have demonstrated that coordinated neuromuscular tasks occur in "behavioral units" under subcortical control. Studies of human motor behavior have concluded further that motor activities are controlled by motor "programs," also independent of immediate feedback control. Combined with other theories and demonstrations, we may hypothesize that, in those patients who benefit from prism location, the body posture and head-eye coordination pattern were sufficiently rigid to mitigate against easy adaptation, and that eccentric viewing without slight head turn (6 to 8  $\Delta$ ) was difficult for these patients. On the other hand, locomotion in a straight line during the normal activities of daily living with the head in other than a straight-ahead posture was also difficult, and assistance by prism correction, which permits normal head position and normal eye position during eccentric viewing, could be an effective treatment for appropriately selected patients. The procedure should be tried where other approaches are ineffective, particularly in view of the minimal-risk nature of such trials.

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