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ORIGINAL ARTICLE

Clinical and Laboratory Evaluation of Peripheral Prism Glasses for Hemianopia

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ABSTRACT

Purpose. Homonymous hemianopia (the loss of vision on the same side in each eye) impairs the ability to navigate and walk safely. We evaluated peripheral prism glasses as a low vision optical device for hemianopia in an extended wearing trial.

Methods. Twenty-three patients with complete hemianopia (13 right) with neither visual neglect nor cognitive deficit enrolled in the 5-visit study. To expand the horizontal visual field, patients' spectacles were fitted with both upper and lower Press-On Fresnel prism segments (each 40 prism diopters) across the upper and lower portions of the lens on the hemianopic ("blind") side. Patients were asked to wear these spectacles as much as possible for the duration of the study, which averaged 9 (range: 5 to 13) weeks. Clinical success (continued wear, indicating perceived overall benefit), visual field expansion, perceived direction, and perceived quality of life were measured.

Results. Clinical success: 14 of 21 (67%) patients chose to continue to wear the peripheral prism glasses at the end of the study (two patients did not complete the study for non-vision reasons). At long-term follow-up (8 to 51 months), 5 of 12 (42%) patients reported still wearing the device. Visual field expansion: expansion of about 22° in both the upper and lower quadrants was demonstrated for all patients (binocular perimetry, Goldmann V4e). Perceived direction: two patients demonstrated a transient adaptation to the change in visual direction produced by the peripheral prism glasses. Quality of life: at study end, reduced difficulty noticing obstacles on the hemianopic side was reported.

Conclusions. The peripheral prism glasses provided reported benefits (usually in obstacle avoidance) to 2/3 of the patients completing the study, a very good success rate for a vision rehabilitation device. Possible reasons for long-term discontinuation and limited adaptation of perceived direction are discussed.

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Key Words: low vision, prism adaptation, rehabilitation, prism treatment, visual impairment, traumatic brain injury, stroke

Homonymous hemianopia is the loss of half the visual field in both eyes on the same side and to the same extent. The visual field loss results from postchiasmal damage to the optic tract or its cortical projections and is contralateral to the side of the brain injury.[1] The most common cause of hemianopia is stroke with most other cases attributed to traumatic brain injury, tumors, and brain surgery.[1] An estimated 682,000 incidents of stroke occurred in the U.S. in 1995,[2] and a third of stroke survivors may suffer homonymous hemianopia.[3] Many of these patients do not regain their lost visual field. Zhang et al.[4] reported spontaneous improvement of homonymous hemianopia for half of patients when tested within the first month following cerebral injury. At 6 months, recovery was found among those patients with reversal of the underlying brain injury (e.g., tumor resection), but no patient with stable brain injury showed further improvement after 6 months. With the expected aging of the population, the incidence of stroke and concomitant prevalence of hemianopic visual field disorders is likely to increase. Given the lack of a cure, there is a need for rehabilitation methods to support the large number of people afflicted.

Rehabilitative approaches to homonymous hemianopia typically fall under three categories: (1) training patients to make better compensatory scanning eye movements[5–8]; (2) restoring a portion of the hemianopic hemifield through training[9]; and (3) the use of optical devices, most commonly prisms.[3,10–14]

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The purpose of optical devices is to expand the visual field. Common optical devices involve using monocular or binocular sector prisms.[3,10–14] The theoretical limitations of these methods were previously reviewed.[13] Sector prisms can only have an effect when a portion of the residual visual field falls within the field of the prism (Appendix 1, Supplemental Digital Content 1, http://links.lww.com/A799). In (complete) hemianopia this means that the gaze is directed through the prism sector. Visual field expansion has not been demonstrated for any of the sector-prism approaches. This is probably because such expansion cannot be measured with either binocular or monocular prism segments fitted in the common configuration. In the case of binocular prisms (full or sector designs), no visual field expansion can occur. In the case of the monocular sector prisms the expansion that may occur (as described in Appendix 1, Supplemental Digital Content 1, http://links.lww.com/A799) is accompanied by disturbing foveal double vision.[10,11] The double vision is reported to be transient,[11] which, as described in Appendix 1 (Supplemental Digital Content 1, http://links.lww.com/A799), may result in a loss of the visual field expansion. Although Gottlieb et al.[12] claimed that patients' visual fields are being restored by wearing of the sector prism, that effect on the visual field was measured without the prism, and the visual fields were never published.

Peli[13] proposed the use of peripheral prism segments placed on the spectacle lens above and below the line of sight (peripheral prisms). Usually applied monocularly on the hemianopic ("blind") side (Fig. 1), and with the base in the direction of the visual field defect. This method expands the binocular visual field (as measured by perimetry) rather than merely shifting it, as do the binocular sector prisms. Importantly, the peripheral prism design avoids the foveal double vision (consisting of diplopia, seeing the same object in two different directions, and visual confusion, seeing two different objects in the same visual direction) that is associated with monocular sector prisms[10,11] (see Appendix 1, Supplemental Digital Content 1, http://links.lww.com/A799). With peripheral prisms, double vision occurs only in peripheral vision, and that is much less disturbing and annoying than foveal double vision.[13]

FIGURE 1.

Peripheral prism correction for a right hemianopic patient wearing spectacles with upper and lower 40Δ (22°) Press-On prism segments affixed base-out to the back of the right spectacle lens.

The central part of the spectacle lens is unaffected, allowing normal binocular vision with the habitual distance prescription (if any). The peripheral prism segments extend across most of the horizontal extent of the spectacle lens and, therefore, are effective at all lateral positions of gaze. It is the peripheral visual confusion and not the peripheral diplopia (which occurs farther in the periphery with this design) that provides the peripheral visual field expansion. Objects that would normally fall in the hemianopic hemifield of the hemianopia-side eye are shifted to the residual (seeing) hemifield and become visible, superimposed on objects seen by the corresponding retinal area in the other (seeing-side) eye. The patient is instructed to use the prism segments only to detect objects in the periphery. Once an object of interest is detected (peripherally) through either prism segment, the patient should then tilt his or her head up (or down) to view the object through the clear portion of the spectacle lens. Peli[13]evaluated this method in a case series with 12 patients. Expansion of the binocular visual field (Goldmann perimetry), was shown for all patients, and most (75%) reported benefit with the peripheral prism glasses, usually reported as better ability to avoid obstacles on the hemianopic side. Although that case series study was deemed clinically successful, no objective functional measures other than visual field expansion were performed.

Our study evaluated functional and subjective rehabilitative effects for patients wearing the peripheral prism glasses in an extended wearing trial. We expected patients to demonstrate visual field expansion as shown by Peli,[13] and hypothesized that some patients may adapt to the change in perceived direction of objects seen through the prism segments, as was demonstrated by Kohler.[15] We wished to find the daily living situations in which the peripheral prism glasses were of benefit or hindrance (or neither) to the patients, and whether patients found the peripheral prism glasses of sufficient value that they would continue to wear them after the end of the study.

Most clinical trials evaluate the efficacy of the treatment; whether the treatment has the intended effect. In an alternative approach, clinical success, can be defined in much the same way as "effectiveness," i.e., does an intervention have the intended effect under normal, everyday use of the treatment?[16,17] Many issues beyond measures of intended effect can contribute to the value of the treatment. Because the efficacy of many low-vision devices and refractive error corrections can be easily demonstrated (such as with contact lenses, where visual acuity improvement is trivial to show), clinical success has been assessed by measuring the continued use by the patients.[18–24] Similarly, continued smoking cessation[25] and continued weight maintenance or loss[26] have been used as measures of real world effectiveness of treatment intervention. In our study, we demonstrated efficacy by showing the visual field expansion and we used continued use of the peripheral prism glasses as our measure of clinical success (effectiveness).

METHODS

Extended Wearing Trial

The effect of the peripheral prism glasses was evaluated during a planned prospective five visit, extended wearing trial of six planned weeks duration (median = 9, range 5 to 13 weeks) (Fig. 2). All patients performed the same tasks and received the same amount of

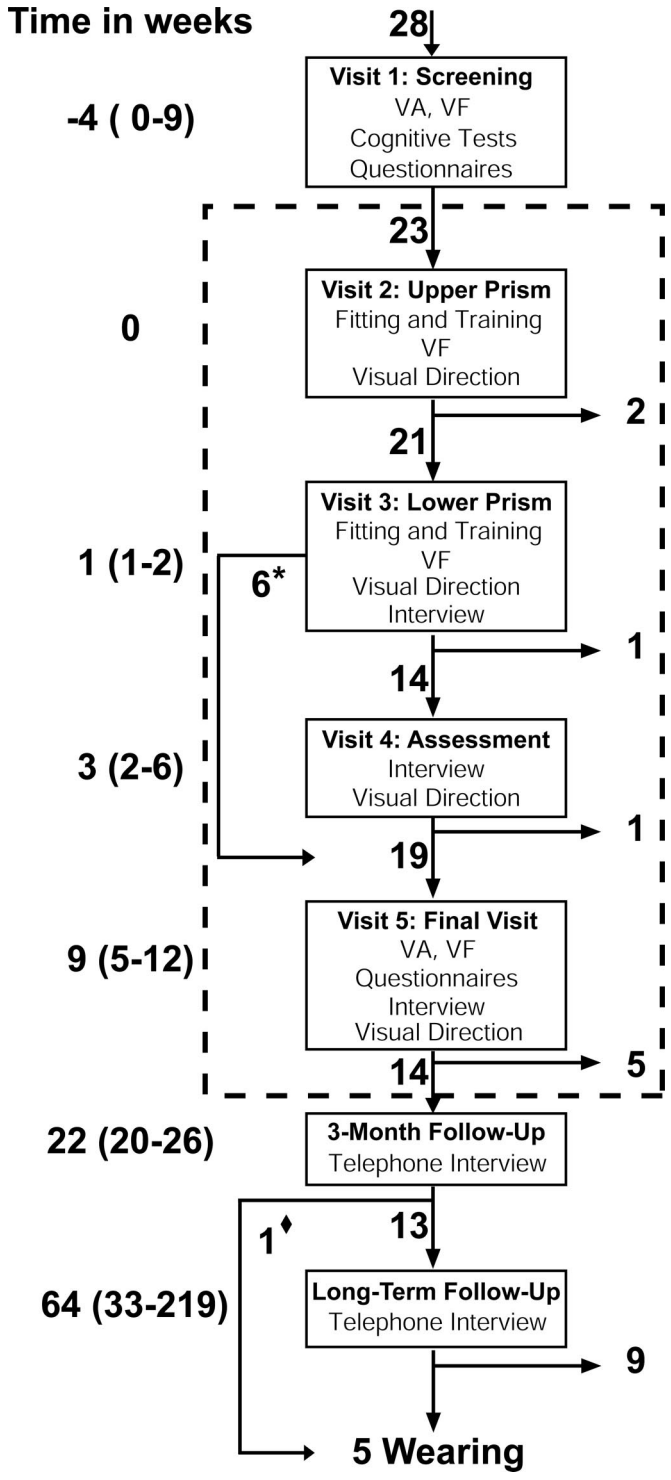

FIGURE 2.

A flow diagram showing the timing of visits, the main procedures at each visit, and the numbers of patients. Numbers on the left of the flow diagram are the median time in weeks (range in parentheses) relative to the first fitting of a peripheral prism segment (upper at visit 2). Numbers next to the down arrows of the flow diagram show the numbers of patients moving to the next stage of the study. The numbers next to a right pointing arrow show the number of patients who discontinued wear of the peripheral prism glasses at each stage. Intentionally, six patients skipped visit 4, shown by the asterisk. The "diamond" indicates the patient who had stopped wearing at 3-month follow-up, but reported wearing the peripheral prisms again at long-term follow-up. The formal visits of the study are enclosed by the dashed rectangle. VA, visual acuity; VF, Goldmann visual field.

in-office training in using the peripheral prism glasses. After an initial inclusion screening at visit 1, eligible patients returned and were fitted with upper and lower prism segments at visits 2 and 3, respectively. The benefits of the peripheral prism glasses were evaluated through the measures: clinical success; visual field expansion; perceived direction; and perceived quality of life. As we did not find adaptation of perceived direction in the first 15 patients tested, six patients skipped visit 4 and perceived direction testing was not performed on those six patients (Fig. 2).

Inclusion Criteria

Patients were required to have complete homonymous hemianopia, best-corrected single-letter visual acuity of 20/50 or better in each eye, understand verbal directions in English, be able to walk unaided for at least 1 h and not have spatial neglect[27–29] or a significant cognitive deficit.[30,31] None of our enrolled patients presented with macular disease, as evaluated with a Rodenstock scanning laser ophthalmoscope[32] (Rodenstock, Munich, Germany) or Nidek MP-1 (Nidek Technologies, Vigonza, Italy).

Visual fields measured with Goldmann perimetry (Haag Streit Perimeter, Haag Streit International, Switzerland, target V4e) during visit 1 were used to determine complete homonymous hemianopia. Complete hemianopia was defined as no residual vision on the hemianopic side of the vertical meridian of more than 5° within 30° above and below the fovea (Fig. 3A). Homonymous hemianopia was defined as between-eye horizontal differences of the vertical hemifield borders extending no more than 10° within 30° above and below the fovea (Fig. 3B). In addition, the seeing hemifield was required to have a minimum temporal horizontal visual field of 60° in the seeing-side eye and a minimum 40° horizontal nasal visual field in the hemianopia-side eye. Only three patients were found to have macular sparing using either the scanning laser ophthalmoscope or the Nidek MP-1.

Spatial Neglect and Cognitive Status Testing

Spatial neglect is a frequent co-occurrence of hemianopia, more common with right hemisphere damage.[33] We excluded patients with spatial neglect using two pencil and paper tests of lateralization: The Bells Test,[27] a cancellation test, in which the patient is asked to find and circle as many of the 35 targets (~0.7 cm^2 silhouette "bell" figures) among 280 distractors (similarly sized, different figures) in a non-timed test; and The Line Bisection Test,[28] in which the patient bisects a series of horizontal lines of differing lengths and position on a sheet of paper. Each test was administered and scored as previously described.[27,28] Our criteria for spatial neglect and hence exclusion from the trial was finding two or more of the following outcomes with the same lateralization:

1. Bells test: A difference in number of missed bells between the left and right sides of the page of four or more.
2. Line Bisection test:
   a. The number of "missed" lines on one side of the page exceeded the number of missed lines on the opposite side by two or more; or,
   b. >10% deviation (average for all lines) of marked center with respect to true center of the lines.

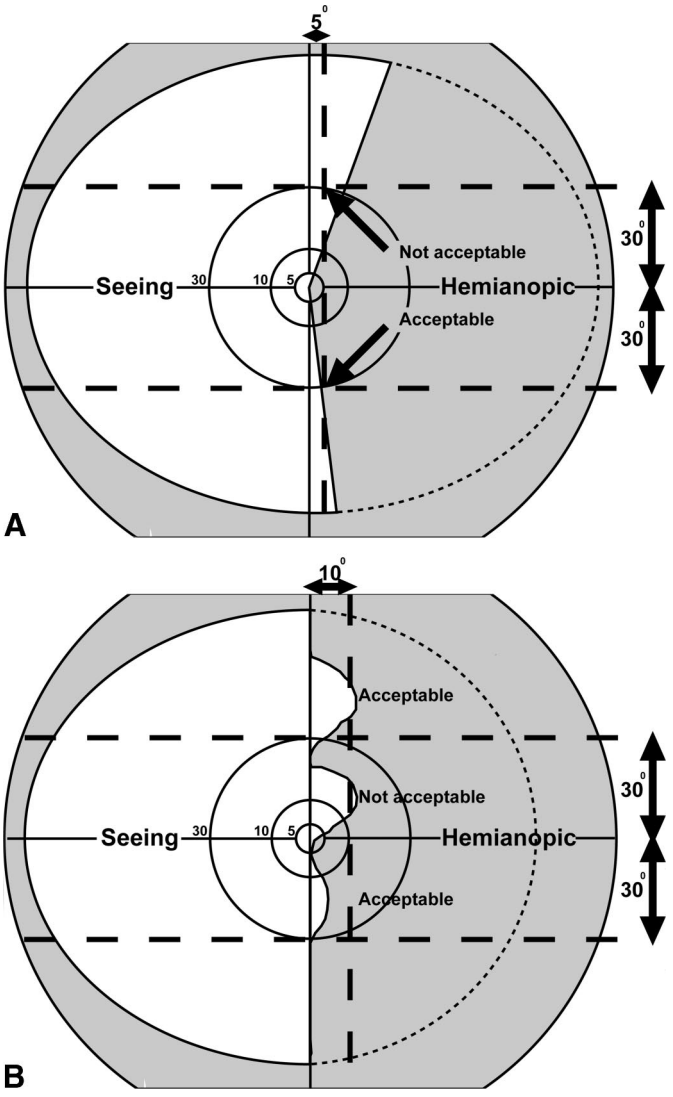

FIGURE 3.

Illustration of the visual field inclusion criteria. The inclusion criteria were applied only to the area of the visual field between 30° above and below the horizontal midline. A, Complete hemianopia test shown in a schematic binocular visual field. As the lower visual field extended <5° beyond the vertical midline within that zone, that quadrant was acceptable. However, the upper visual field extended more than 5° making this hypothetical patient ineligible for the study. B, Homonymous hemianopia test illustrated with this schematic left eye monocular visual field. For this illustration, the right eye is assumed to have "ideal" hemianopia following the vertical meridian, hence a difference between the two eyes above or below 30° lines extending >10° beyond the vertical midline was acceptable, whereas the same difference within 30° of the horizontal midline was not acceptable. A difference between the two eyes extending <10° from the vertical midline in the latter zone was acceptable. The dotted lines in A and B represent normally-sighted binocular and monocular visual fields, respectively.

An estimated 75% of stroke victims have some residual cognitive impairment.[31] We excluded patients with significant cognitive deficits as determined by the Mini-Mental State Exam (Psychological Assessment Resources, Lutz, Florida) using a score of 24 or more of 30 questions correct for inclusion in the trial (mean score for a healthy comparison group was reported as 26[30]).

Patients

Twenty-eight patients, referred by local neuro-ophthalmology clinics and deemed suitable based upon an initial telephone interview, were screened for participation. Four patients did not meet the visual field criteria (Fig. 3), and one could not walk unaided for 1 h. The 23 (14 male) patients who were enrolled had an average age of 46 years (range 16 to 72 years). Etiology of their hemianopia was 16 from stroke, four from brain tumor resection, two from traumatic brain injury, and one had congenital hemianopia. At time of study enrollment, the median time from injury was 8 (range 2 to 189) months. The median binocular single-letter visual acuity of enrolled patients was −0.10 logMAR (20/16, range 20/11 to 20/32).

Only one enrolled patient missed more than one target on one side of the Bells test relative to the other. Only one patient missed more than one line on one side of the Line Bisection test relative to the other, and only three patients showed more than 10% mean deviation in marking the center of lines (average absolute deviation 5.3%, range 0.2 to 10.6%). The average Mini-Mental State Exam score was 28 (range 24 to 30).

The enrolled patients had stable visual status during the study. Only two patients had more than a 0.1 logMAR (one line) difference in visual acuity between visit 1 and visit 5, which was due to a change in their prescription glasses after visit 1. No patient showed a change in monocular visual fields of more than 5° at the hemifield border (between 30° above and 30° below the horizontal meridian) when comparing Goldmann visual fields at visit 1 and visit 5.

The study protocol was approved by the Schepens Eye Research Institute Institutional Review Board. All patients signed the Informed Consent form.

Peripheral Prism Glasses Description, Fitting and Training

We used 40 prism diopter (Δ) Press-On Fresnel prisms (3M Health Care, St. Paul, MN).[13] Separate prism segments were used for the upper and lower visual fields. Both prism segments were placed base-out on the spectacle lens on the hemianopic side. Prism segments were cut to the shape of the spectacle lens and placed across the top and bottom of the spectacle lens (Fig. 1). The straight, lower edge of the upper prism segment was aligned with the superior limbus. The position of the lower prism was found using an object on the floor as described by Peli.[13] Typically, this resulted in the prism segment edges being 6 mm above and below the pupil center on primary gaze.

Patients with no prescription spectacles and those with frames that were too small required new spectacles. They were provided with instructions to the optician regarding the required frame dimensions: Vertical B measure (the box system for specifying frames) of at least 40 mm and, when worn, the top of the lens at the height of the eyebrow. Patients were provided $100 towards the purchase of a frame or could choose from a limited selection of frames that we had available. Only single vision spectacles were issued and used in this study.

Patients were fitted with the upper prism segment at visit 2, and with the lower prism segment at visit 3 (Fig. 2). At each prism fitting, the patient was reminded to look through the clear (non-

prism) central part of the spectacle lens and not through the prism segments. The patient was directed to make a vertical head movement so that an object of interest detected with the prism segment was viewed through the central portion of the spectacle lens. In normal vision, foveating eye movements usually precede such head movements. The patient was instructed to limit such eye movements to avoid foveal double vision (similar alterations in behavior are usually required for successful use of bifocal or multifocal spectacles). We told patients that initially these head movements would require conscious behavior, but over time they should become automatic.

At visit 2, the experimenter conducted a training exercise in which the patient's gaze was directed at the experimenter's nose, while the experimenter's hand was moved on the hemianopic side so that the patient could detect it peripherally through the prism segment. The patient was instructed to reach for the experimenter's hand, ballistically (i.e., rapid movement with no opportunity for visual feedback). Initially, reaching was inaccurate, as might be expected with vision through prisms,[34] but it became accurate after a few trials, as is common in prism adaptation experiments.[34] Although these hand movements were ballistic, the response was closed loop (i.e., there was visual feedback following completion of each hand movement).

The experimenter then walked with the patient through the institute corridors while wearing the upper prism segment and instructed the patient to pay attention to potential obstacles such as door frames and furniture. Finally, the patient was asked to walk up and down a flight of stairs, to confirm that the upper prism segment would not impede mobility (for safety, the patient was encouraged to always make use of handrails).

The patient was instructed on two brief training tasks which were to be performed at home at least twice every day:

a. Reaching and touching task that utilized the prism segment and its altered visual direction, and
b. Detecting and head movement task, designed to train the patient to avoid foveal double vision caused by fixating through the prism segments.

At visit 3, training in the use of the lower prism segment was similar to that of the upper prism segment. The patient was informed that adjustment to the lower prism segment might require more time, as it may initially impair mobility tasks such as stepping off curbs or ascending and descending stairs. When the patient walked up and down a flight of stairs, the patient was instructed to tilt the head down to use the central portion of the spectacle lens, again using handrails whenever possible. The patient was reminded of the two training tasks and further instruction and training was provided if necessary.

Clinical Success and Patient Interviews

We defined a patient as clinically successful if that patient was still wearing the peripheral prism glasses and chose to continue to wear the peripheral prism glasses. Continued wearing of the peripheral prism glasses was taken to indicate that the patient perceived the peripheral prism glasses to be of overall benefit in their daily mobility situations. The primary measure of clinical success was made at the end of the study (visit 5). In addition, we report clinical success at long-term follow-up (Fig. 2).

At visit 5, 3-month follow-up and long-term follow-up, the investigator recorded responses to formal questions covering peripheral prism glasses use, benefits and difficulties attributed to the glasses and willingness to pay for a pair of permanent peripheral prism glasses. During the interviews, the investigator could elicit additional descriptive responses to open-ended questions that would prompt further questions. At the visit-5 interview, a joint decision was made based upon the patient's perceived benefit from the peripheral prism glasses and the clinician's opinion, as to whether the patient should continue to wear them. If the patient and clinician thought continued wear was indicated, the patient was shown a sample pair of permanent peripheral prism glasses that the patient could order as an alternative.

We asked patients to wear the peripheral prism glasses as much as possible during the course of the study. After fitting of the upper prism segment (visit 2) patients were given a take-home wearing diary to record each day the number of hours per day that the peripheral prism glasses were worn. The form also had an open-ended comments section in which patients could record any difficulties or benefits experienced with the peripheral prism glasses. Patients were asked to return the diary to us at the subsequent visit and were given a new diary at visit 3 and visit 4 with the same instruction. During the interview at each visit, the investigator asked the patient for an estimate of the hours worn per day since the last visit, and these responses were used as data if the diary was not available. Of the 46 diaries provided, 29 were completed and returned (63%).

Visual Field Expansion

Kinetic perimetry was conducted using a V4e target on a Goldmann perimeter. Binocular visual fields were measured at visits 2, 3, and 5 (Fig. 2): at visit 2, with and without the upper prism segment; and at visits 3 and 5, with and without the upper and lower prism segments. Visual field expansion was measured as the horizontal distance (in degrees) between the unaided (no prism) vertical hemifield border and the same point measured with the prism segment (Fig. 4). The expected expansion for the 40Δ prism segments was about 22°.

Perceived Direction

We defined perceived direction as the perceived (angular) position of an object relative to the line of sight. Prisms alter the apparent visual direction of objects. Initially, the perceived direction of an object seen through a prism is not veridical (correct). People can rapidly adapt to the perceived direction of objects seen through full lens binocular prisms.[15,34,35] Kohler,[15] who wore a binocular half-prism every waking moment for 10 days, reported a "dual" adaptation to the view through the prism and to the view through the prism free lens. We hypothesized that patients wearing the (monocular) peripheral prism glasses might adapt in a similar manner.

We measured perceived direction using a pointing task at visits 2, 3, 4, and 5 (Fig. 2). Viewing was always binocular. Patients were seated 1 meter from a wide rear projection screen (81° by 64°) (Fig. 5). Large head movements were restricted by a chin-rest and a tight

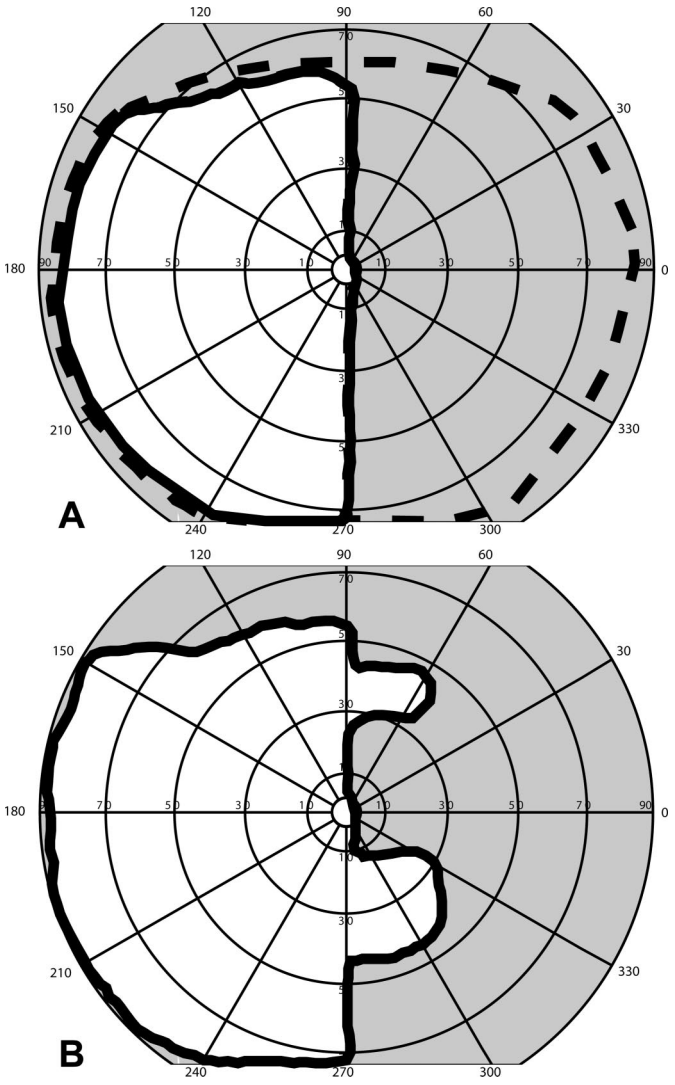

FIGURE 4.

A, Binocular visual field of a patient with right homonymous hemianopia is shown enclosed by the thick solid line. For comparison, the dashed line shows the binocular visual field of a normally-sighted subject. Stimuli presented in the gray portion were not seen by the patient. B, Binocular visual field of the same patient wearing peripheral prism glasses. The difference in the visual field plots represents the visual field expansion provided by the peripheral prisms glasses. V4e target used for Goldmann kinetic perimetry.

headband. Patients indicated the perceived direction of stimuli (2° blinking, black circles) on the screen by pointing a computer mouse held in the hand over a large graphic bitpad (90 × 120 cm). Testing was open-loop as a wooden box over the bitpad prevented the patient from viewing their arm, hand or mouse and the mouse icon was not visible on the display. Patients wore a brace to limit flexion of the elbow (Fig. 5) and were asked to not flex the elbow or the wrist, so that pointing was only from the shoulder. A pointing calibration step adjusted for individual differences in response. During pointing calibration the patients could turned their eyes (but not head) toward each approximately eye-level target.

After pointing calibration, the locations of the prism edges were located on the screen. A staircase procedure was used, in which stimuli (2° blinking, black circles) were presented along a vertical

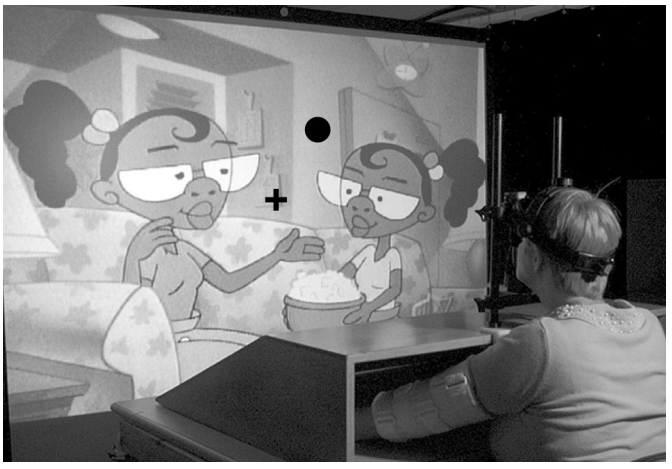

FIGURE 5.

Experimental set-up and apparatus for perceived direction testing. Patients sat 1 m from a rear projection screen with their arms and hands occluded from view by use of a wooden box placed over a large bit pad on which patients could swing their arm, left and right. A brace was worn on the pointing arm to reduce flexion of the elbow. The patient's task was to "point" to each seen stimulus and indicate its horizontal position by a mouse click. Stimulus locations are illustrated in Fig. 6. The background images were low contrast, grayscale images derived from cable television. For illustrative purposes, the contrast of this cartoon image here is higher and the size of the fixation target and circular stimulus greater than during actual perceived direction testing.

line 6° to the left or right of the vertical midline on the hemianopia side of the fixation cross. While fixating the cross, the patient would respond when the target became visible. This process located the horizontal edges of the upper and lower prism segments in the visual field.

Once the location of the prism segments were mapped, test stimuli (2° blinking, black circles) were presented in one of eight zones (Fig. 6) in random order. Stimuli presented in zones A and D should be visible as they were presented in the seeing hemifield. Stimuli in zone D could be perceived as doubled, as one eye saw it through the prism. Stimuli presented in zone B were not expected to be seen, as they were presented in the hemianopic hemifield and not within the prism segment visual field. Stimuli presented in zone C were expected to be seen through the corresponding prism segment. Twelve stimuli were presented in each zone (three vertical by four horizontal positions). For each trial (stimulus presentation) the patient maintained central fixation. If the patient detected the stimulus (either through a prism segment or via the seeing hemifield), she or he shifted the outstretched arm over the bitpad until she or he was pointing in the perceived direction of the stimulus. For stimuli seen as doubled (i.e., those presented in zone D), the patient was instructed to point in the "correct" direction. Each trial of visual direction testing was presented over a different low contrast TV image (Fig. 5). To determine adaptation, perceived direction was plotted against real direction (Fig. 7), and data for zone C (prism) and zones A and D (seeing hemifield) were fitted with separate straight lines with the same slope. The difference in y-intercept between the perceived direction for stimuli presented in the prism zone (zone C) and those presented in the seeing hemifield (zones A and D) was used as the outcome measure. Adaptation of perceived direction would appear as an overlap of these two lines with no difference in the intercept (Fig. 7B).

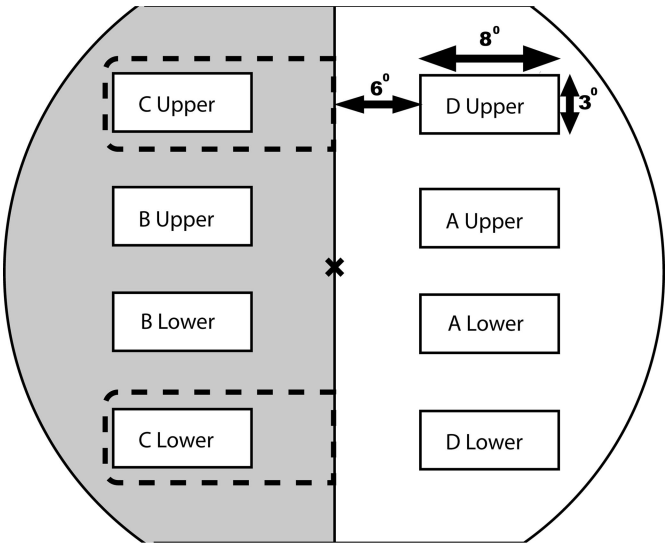

FIGURE 6.

Perceived direction testing: patients were presented 12 stimuli in each of eight zones, four zones in the hemianopic side (here left of vertical midline, 2 upper and 2 lower) and four zones in the seeing side (here right of vertical midline, 2 upper and 2 lower). Stimuli presented in zones "A" and "D" were detected in the seeing hemifield and were expected to be reported by the patient in the real direction. Stimuli presented in zones "B" were not expected to be detected by the patient, as these were presented in the hemianopic hemifield not covered by prism. Stimuli presented in zones "C" were expected to be detected through the prism segments shown as dashed lines and reported in the visual direction, demonstrating no adaptation of perceived direction, or in the real direction, demonstrating adaptation of perceived direction. The "X" represents the fixation target.

Perceived Quality of Life

To determine how the peripheral prism glasses affected perceived quality of life, we administered two questionnaires at visits 1 and 5 (Fig. 2). Both questionnaires, National Eye Institute Visual Function Questionnaire-25[36–38] (NEI-VFQ-25, version 2000) and the Independent Mobility Questionnaire[39] (IMQ), contained items relating to daily living activities. The patient reported their perceived level of difficulty for each item. In addition to analyzing all questions of both questionnaires, we conducted planned analyses of responses to subsets of questions that we expected would be sensitive to the effects of the peripheral prism glasses. These questions related to mobility and obstacle avoidance: NEI-VFQ-25 questions 7, 10, 14, 15c, 20, 24, A2, A7, A11a & b, and A13; and IMQ questions 1, 2, 4, 6 to 8, 10, 13 to 17, 24 to 33, and 35 (Appendix 2, Supplemental Digital Content 1, http://links.lww.com/A799). A modified Rasch analysis,[40] which estimates interval scales for ordinal data, was used to transform the raw scores of responses to the items of each questionnaire.

Non-parametric tests were used in the data analysis. The Wilcoxon test was used for paired comparisons and the Mann-Whitney test for unpaired comparisons. We report test results as statistically significant when $p \leq 0.05$. However, because of our small sample size, we have reported test results as "approaching" significance when $0.05 < p \leq 0.10$. A Bonferroni correction for the number of NEI-VFQ and IMQ questions tested (33 combined questions) would have required a $p < 0.002$ for significance.

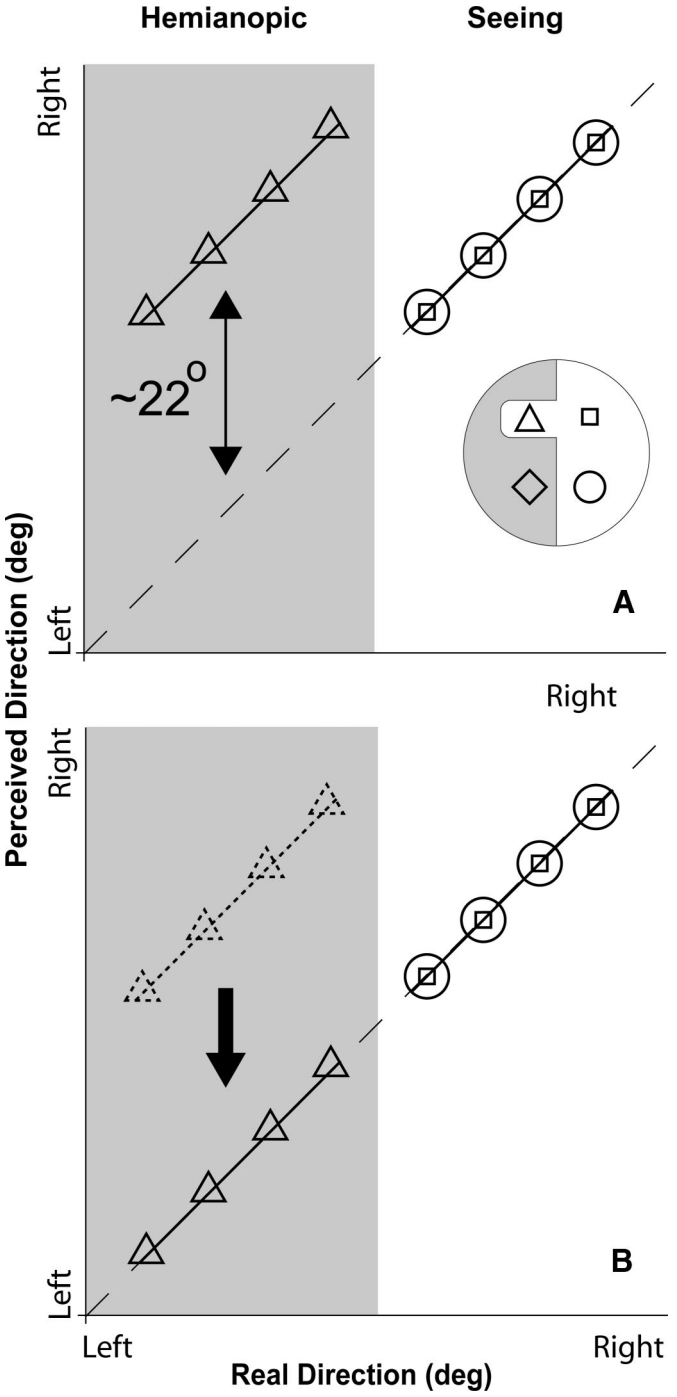

FIGURE 7.

Idealized schematic data showing "no adaptation" and "adaptation" of perceived direction with prism segments worn by a patient with left hemianopia. A, Stimuli detected in the seeing hemifield are reported in the real direction (i.e., the patient points correctly to the stimulus presented on the screen). Stimuli presented in the hemianopic hemifield and detected through prism segments have a visual direction that is shifted about 22° relative to the real direction by the 40Δ prisms. The perceived direction is the visual direction indicating no adaptation to the prism shift. B, Stimuli seen in the seeing hemifield are reported as in (A), but stimuli seen through prism segments are reported in the real direction despite the prism shift of visual direction, showing adaptation of perceived direction.

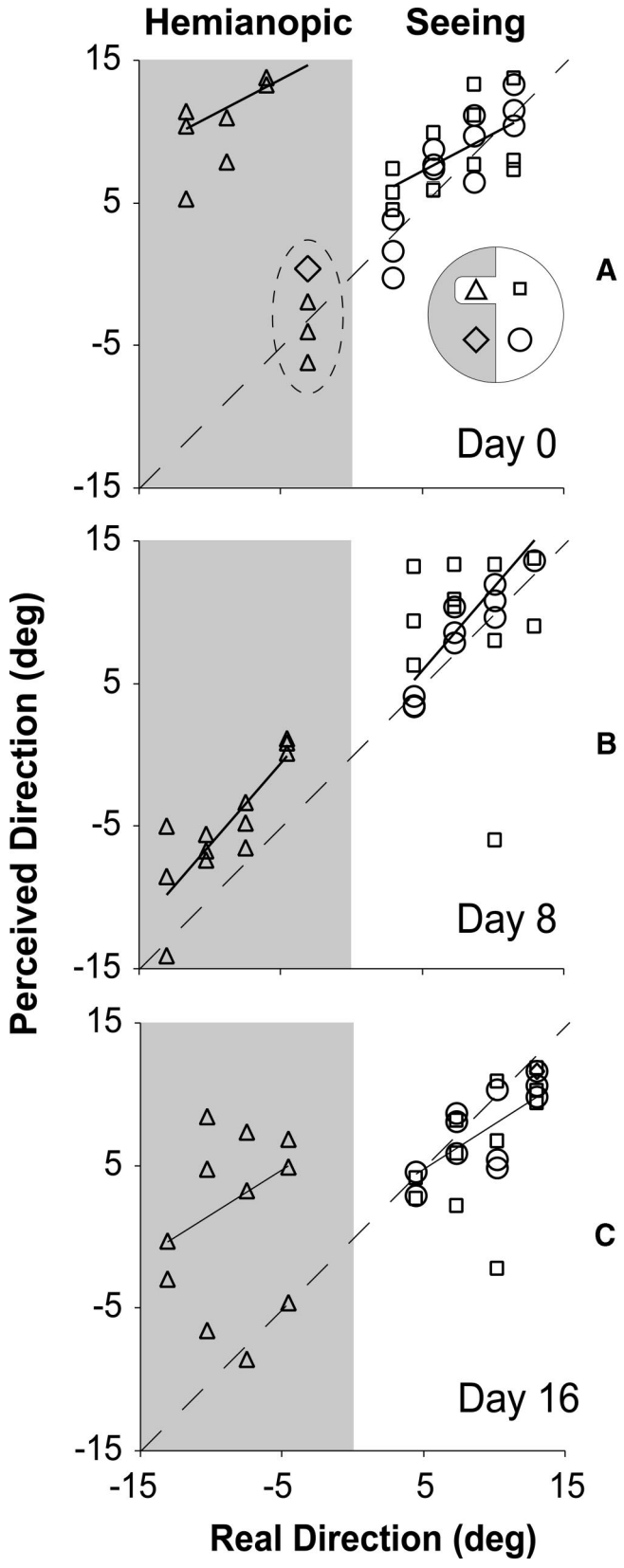

FIGURE 8.

Perceived direction of stimuli presented to the upper half of both the seeing and hemianopic hemifields for one patient with left hemianopia. A, Results on the day of the upper prism segment fitting show no adaptation to the prism-induced change in visual direction. Stimuli seen through the prism segment (triangles, C Upper in Fig. 6) were perceived about 22° to the right of the real direction, the expected deviation for the 40Δ power of the segment. Three of these stimuli, presented close to the hemifield border were detected by "peeking" into the hemianopic hemifield (dashed ellipse). Stimuli presented to the hemianopic hemifield in the non-prism zone (diamonds, B Upper) were not seen except for one stimulus again detected by "peeking" (dashed ellipse). Stimuli presented to corresponding zones in the seeing hemifield (squares, D Upper and circles, A Upper) were perceived in the real direction. B, Results 8 days after the upper prism segment fitting in which the patient reported wearing for an average of 6 h/d. For stimuli seen through the prism segment the patient reported the stimuli direction as close to the real direction, demonstrating an "adaptation-like" response. However, the patient reported that he was making conscious, compensatory motor responses, which in (C), another 8 days later are no longer reliably demonstrated. No adaptation was seen at visit 5 (data not shown).

RESULTS

Of the 23 patients who met the eligibility criteria, two patients did not complete the study for non–vision-related reasons, and two other patients decided not to continue with the study, citing no perceived benefit from the peripheral prism glasses (Fig. 2). Thus, 19 patients completed the study. Unless otherwise noted, analyses of data on subsequent measures were restricted to this group of 19 patients for which we had almost complete data. Fourteen of the 19 patients reported sufficient perceived benefit from the peripheral prism glasses during the course of the study that they chose to continue to wear after the study (visit 5) in their daily mobility situations. Of these 14 "successful wearers," two patients eventually purchased the permanent peripheral prism glasses. Of the five "non-successful wearers": two patients discontinued using the peripheral prism glasses before visit 5, but did complete the study visits; and three patients were wearing the peripheral prism glasses at visit 5, but chose to discontinue wear at the end of the 5-visit study.

After completion of the planned study, at the nominally 3-month follow-up (range 9 to 23 weeks) 13 of those 14 successful wearers were still wearing the peripheral prism glasses. At long-term follow-up (median 64, range 33 to 219 weeks), we were able to contact 11 of those 13 patients who continued to wear the peripheral prism glasses at the 3-month follow-up interview. In addition, the patient who had discontinued wear at the 3-month follow-up, restarted wearing the peripheral prism glasses again independently (indicated by the "diamond" in Fig. 2). Of these 12 patients that we contacted for long-term follow-up, four had discontinued wear due to non-vision problems, three discontinued due to a loss of the perceived visual benefit, and five were still wearing the peripheral prism glasses.

Clinical Success and Patient Interviews

Excluding the two patients who left the study for non-vision reasons, two thirds (14/21) of patients chose to continue to wear the peripheral prism glasses at the end of the study. At long-term follow-up, 5 of the 12 (42%) long-term wearing patients who could be contacted were still wearing the peripheral prism glasses. Overall, this was a long-term success rate of 24% (5/21 patients fitted with both peripheral prisms). If patients who discontinued for non-vision reasons are excluded, the long-term success rate was 29% (5/17).

Analysis of patient responses to the open-ended questions of the visit-5 interview revealed that perceived benefits typically fell into

a few broad categories. For successful wearers, 10 of 14 (71%) reported a perceived benefit in "walking," 3 of 14 (21%) reported a benefit in "crowd" situations, and 3 of 14 (21%) found the peripheral prism glasses useful in "supermarkets" and "shopping malls." One successful wearer found the peripheral prism glasses useful in "searching" for objects on his desk. Only one non-successful wearer reported perceived benefits, namely "watching" sporting events and "driving" (all patients were advised about driving safety and regulations).

Perceived difficulties with the peripheral prism glasses were more varied than perceived benefits. Two of 14 (14%) successful wearers reported difficulty in crowds, and two more reported difficulty with descending stairs. One non-successful patient also reported navigating stairs as troublesome when wearing the peripheral prism glasses. Other reported difficulties included: glare, which we suspect is a consequence of the optical quality of the Press-On prism segments; "anxiety" or "startle" associated with the sudden appearance of objects detected through the prism segments (i.e., jack-in-the-box effect), and; reading and other near-vision activities for which the peripheral prism glasses is not intended.

The 14 successful wearers wore the peripheral prism glasses more hours per day (median 4.1, range 1.0 to 13.4 h/d) than did the five non-successful wearers (median 2.0, range 0.4 to 4.6 h/d) (Mann-Whitney $Z_{18} = 1.95$, $p = 0.05$).

Visual Field Expansion

As 40Δ prism segments deviate light approximately 22°, we expected visual field expansion to extend laterally into the hemianopic hemifield by about that amount, and to extend vertically by the height of the prism segment (which varied with the frame size). All patients showed the expected visual field expansion for both the upper and lower prism segments. The median measured horizontal visual field expansion for the upper prism segment was 23° (range 20 to 24°) and lower prism segment was 22° (range 20 to 24°).

Perceived Direction

No patient in the trial showed a consistent adaptation to the prismatic image displacement. Only two patients showed a transient ability to correct for the displacement. Fig. 8 shows perceived direction testing data for one such patient. At visit 2 (fitting of the upper prism segment) the perceived direction was the prism induced visual direction (i.e., the perceived direction was about 22° to the right of the real position: Fig. 8A). At visit 3 the patient demonstrated a change of the perceived direction to about 5° to the right of the real position (Fig. 8B). On the subsequent visit (visit 4), some stimuli were coincident with the real position whereas the rest were scattered between the real position and the prism displaced image. On briefing, that patient reported making conscious adjustments to the reported position based upon where he thought the stimulus should actually be located in real space. Possible reasons for the lack of adaptation are addressed in the discussion.

Perceived Quality of Life

Analyses were performed for those patients completing one or both questionnaires. There was no significant difference between the visit 1 and visit 5 average questionnaire scores for all patients completing the study (NEI-VFQ-25, Wilcoxon $Z_{15} = 0.41$, $p = 0.68$; IMQ, Wilcoxon $Z_{16} = 0.16$, $p = 0.87$), or for the successful wearers (NEI-VFQ-25, Wilcoxon $Z_{12} = 0.35$, $p = 0.97$; IMQ, Wilcoxon $Z_{13} = 0.28$, $p = 0.78$). Planned analyses were performed on specific questions within each questionnaire (Appendix 2, Supplemental Digital Content 1, http://links.lww.com/A799). For NEI-VFQ-25 question 10, a decrease in difficulty noticing objects off to the side while you are walking along, was found to be significant for all patients completing the study (Wilcoxon $Z_{15} = 2.70$, $p = 0.007$) and for successful wearers (Wilcoxon $Z_{12} = 2.98$, $p = 0.003$). When comparing results between visit 1 and visit 5 several other questions approached significance ($0.05 < p \leq 0.10$). For the successful wearers, these were question IMQ 14, walking down steps, which demonstrated an increased difficulty when wearing the peripheral prism glasses (Wilcoxon $Z_{12} = -1.63$, $p = 0.10$); IMQ 24, being aware of another person's presence, which decreased in difficulty (Wilcoxon $Z_{12} = 1.60$, $p = 0.10$); IMQ 28 avoiding bumping into shoulder-height objects, which decreased in difficulty (Wilcoxon $Z_{12} = 1.60$, $p = 0.10$); and IMQ 30 avoiding bumping into knee-height objects, which decreased in difficulty (Wilcoxon $Z_{12} = 1.60$, $p = 0.10$).

DISCUSSION

Fourteen of 21 (67%) patients were clinically successful, choosing to continue to use the peripheral prism glasses. This clinical success rate is similar to that found by Peli,[13] who reported 9/12 (75%) of patients continued to wear the peripheral prism glasses at the last follow-up (2 to 18 months). At our long-term follow-up (8 to 50 months), only 5/12 (42%) patients reported that they were still wearing the peripheral prism glasses. It should be noted, however, that four patients had discontinued use due to health problems not related to their vision. We consider these rates to be very encouraging.

We believe that some patients stopped wearing the peripheral prism glasses because of the degradation of the optical quality of the temporary Press-On material over time: two patients—who were still wearing at long-term follow-up—reported that the segments became a hindrance when the optical quality deteriorated. After months of exposure to ambient ultra-violet light, dust, skin oil and facial lotions, the optical performance of this soft plastic degrades sufficiently to undermine its functional value. Despite being advised of the need for regular replacement of the Press-On prism segments, after completion of the study (visit 5), none of our patients contacted us to request replacement prism segments and none reported receiving replacement prism segments from other sources. We recommend planned, scheduled (every 3 to 4 months) replacement of the Press-On prism segments if this type of prism is used long term, but it is not a convenient long-term solution. Recently, in collaboration with Chadwick Optical (White River Junction, VT), we developed a permanent peripheral prism lens using a more durable plastic (Polymethyl methacrylate) which, in addition to providing better initial optical quality, is easy to clean and maintains image quality for an extended period. In a follow-up to a multi-center clinical trial of the peripheral prism glasses,[41] 15 patients were dispensed these new permanent peripheral prism glasses. More of these patients continued to wear the peripheral

prism glasses than those who chose to continue to wear the, Press-On prism segments. Two of our patients were fitted for permanent peripheral prism glasses after the study.

It is possible that for presbyopic subjects, the need to inconveniently swap the peripheral prism glasses for their reading glasses affected perceived benefit. Only two of our patients habitually wore bifocals before our study, and at the end of the study, both chose to continue to use the peripheral prism glasses. Five other patients, also clinically successful, used separate reading glasses before our study. However, we believe that peripheral prism glasses should include an option for a reading addition. To this end, Bowers et al.[41] developed a modified press-on prism segment fitting protocol for bifocal and progressive addition lenses in which a small, semi-circular aperture is cut out of the lower prism segment, allowing the patient to use the peripheral prism glasses for spot reading. The current permanent peripheral prism glasses can include a (small and low) bifocal segment.

Low-vision mobility devices may improve function at different levels and in different environments. Detection of objects of interest (e.g., potential obstacles) may occur, but the response (e.g., avoidance maneuver) may or may not be calibrated and valid (e.g., the response action may be inaccurate). Detection or response might be found only in simple, visual environments (e.g., over a blank test background, as in perimetry), but not in more complex visual environments (where visual masking or rivalry might interfere). Although correct and timely detection combined with veridical action in complex real world situations may be ideal, detection alone may still be effective. Peripheral prism glasses may provide the patient with a warning about the presence of an obstacle that could represent an imminent collision, then a response may be initiated once the object is fixated through the (non-prism) center of the spectacle lens.

The peripheral prism glasses provided detection in a simple visual environment as demonstrated by the visual field expansion (Fig. 4). Wearing the peripheral prism glasses improved obstacle avoidance in real life as reported by the patients and thus supported the concept of obstacle avoidance in complex visual environments. There was also borderline evidence that avoidance action was improved. Based on the findings of Kohler[15] and others,[34,35] we had hypothesized that patients would obtain veridical perceived direction perception of objects seen through the prism segments. None of the patients in our trial demonstrated such veridical perceived direction of objects in our pointing task. The failure to adapt to the change in visual direction may have been due to (1) a relatively short and intermittent wearing period (median 4.1 h/d, compared with Kohler's full-time wearing schedule); (2) our training procedures were inadequate; (3) in general, patients failed to perform the in-home exercises; (4) our instructions to patients to avoid looking through the prism segments; (5) our prism segments were fitted monocularly and not binocularly like Kohler's subjects (though our design may be fitted binocularly and still be effective); and (6) the higher power of our prism segments, which was more than double the prism power used by Kohler.[15] Adaptation of perceived direction may not occur when the non-veridical visual direction is in peripheral vision only. In Kohler's experiment, the prism was worn so that objects seen through the prism were viewed intermittently by central vision. We are aware of no study in which subjects demonstrated adaptation of perceived direction when using segments of a high power prism placed peripherally. As we believe the peripheral prism glasses will be of greater value to the patients if they are able to adapt their perceived direction, we are developing training and fitting methods that may provide such adaptation. Our clinical recommendation is that patients should initially be fitted with the Press-On prism segments, and instructed to wear them for a period of 2 months to (1) become adjusted to the change in peripheral visual direction, and (2) decide whether they find the peripheral prism glasses of functional value. Then, patients who decide to continue using the peripheral prism glasses should be fitted with permanent peripheral prism glasses. We note also that the use of the peripheral prism glasses does not preclude other forms of rehabilitative therapy, but can complement any benefits received from those such as compensatory eye scanning training or vision restoration therapy.

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APPENDIX 1

Monocular and binocular sector prisms are commonly used for hemianopia.[3, 10, 14] The impact of these prisms on the visual field is not adequately addressed in the literature.

Binocular prisms (full or sector designs) cannot produce visual field expansion, instead, when looking into the prism, visual field shifting will occur.[10, 13] Rossi et al.[3] reported expansion of the visual field (that was not shown or illustrated) with the use of binocular sector prisms, measured on a tangent screen, but they found similar qualitative expansion in 7 of 17 control subjects with no prism. When we measure the visual fields of hemianopes with the binocular sector prisms fitted as described by Rossi et al.[3] we find no impact of the prism on the visual field. When looking into binocular sector prisms (by turning the head towards the seeing side in the perimeter while continuing to fixate on the perimeter's fixation target) the visual field will be split into two segments, with a scotoma between the two segments.[10, 13] That prism scotoma is a vertical slice the width of which is equivalent to the sector prism power expressed in degrees. Such optical scotoma always exists at the apex of a prism. Thus, although the left-most and right-most edges of the measured visual field are farther apart, the visual field is not actually expanded, since the extent of the visible visual field is the same, just split and with an optical scotoma imposed centrally.[10] Expansion requires that the visual field be wider. Further, the field as measured in the perimeter is unaffected on the hemianopia side of the fixation target. Note also that the prism optical scotoma is close to the primary line of gaze on the hemianopic side, and thus likely to obscure obstacles with which the wearer may collide, while the field "expansion due to the shift occurs at the far end of the seeing hemifield where it is less important.

Visual field restoration following use of monocular sector prism (measured without the prisms) was reported by Gottlieb.[3, 12] However, no measurements of visual fields have been published supporting this claim. Szlyk et al.[14] measured Goldmann visual fields without and with the monocular sector prisms but did not report the results of these measurements.

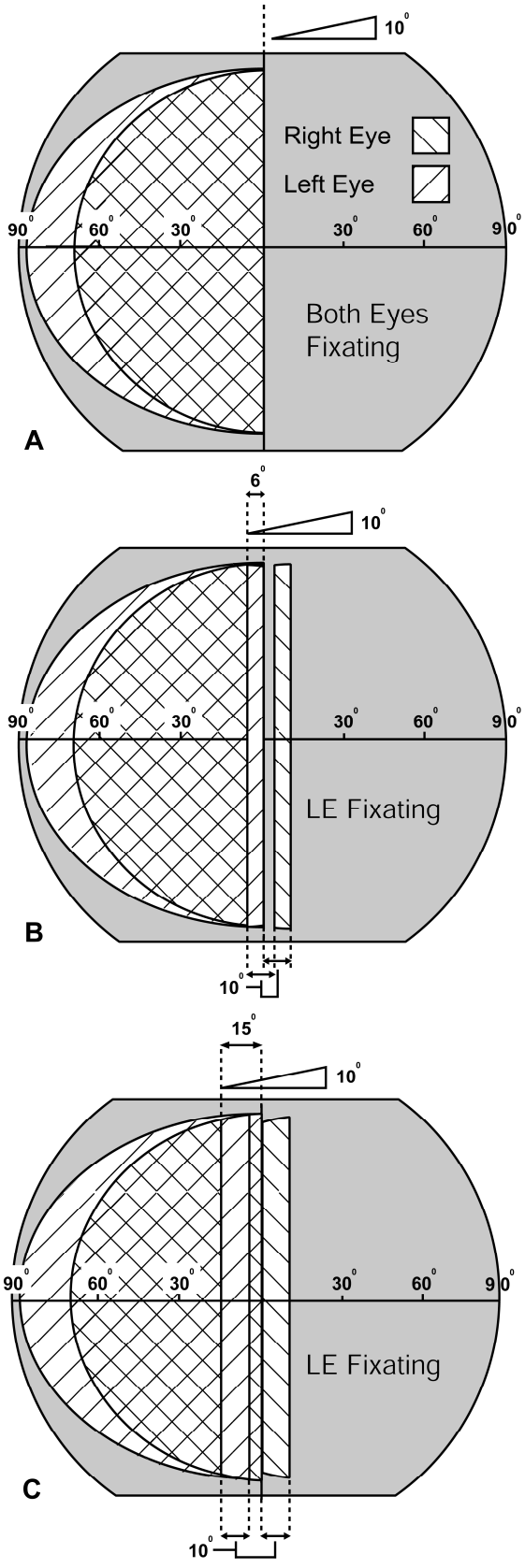

FIGURE A1.
Expected binocular visual fields (white regions) of a person with right homonymous hemianopia with a 10° monocular sector prism worn over the right eye. In this figure it is assumed that the left eye maintains fixation and that the patient remains orthophoric. The direction of visual axis of the eye relative to the prism apex (altered by turning the head left while maintaining fixation) is shown at the top of each panel. Binocular overlap occurs in the cross-hatched regions. **A**. When not looking through the prism there is no effect on the binocular visual field and thus no expansion. **B**. When the visual axis is directed slightly (that is less than the prism power, here 10°) into the prism (here 6°) there is visual field expansion represented by the sliver of right eye vision to the right of fixation. Note the narrow non-seeing gap (scotoma) between two seeing segments of the binocular visual field. There is also foveal double vision (visual confusion). **C**. When the visual axis is directed farther than the angle equivalent to the power of the prism towards the prism base (here 15°) there is visual field expansion with no gap. There is foveal double vision (both visual confusion and diplopia in this case).

Monocular sector prisms can produce visual field expansion when the user is looking into the sector prism,[10] as schematically illustrated in Fig. A1. The monocular sector prism is worn over the hemianopia-side eye (the right eye in Fig. A1). Fig. A1a illustrates that no visual field expansion is expected when the wearer is not looking into the monocular sector prism. Here there is (usually) normal binocular foveal vision (i.e. fusion) and normal peripheral double vision (physiological diplopia) in the remainder of the area of binocular overlap (cross hatched) outside the small area of the horopter. This is shown for a right hemianopic patient in Fig. A2a. Her binocular visual field measured with the Goldmann perimeter was the same with and without the monocular sector prism (when not looking into the prism).

As illustrated in Fig. A1b, when looking into the right monocular sector prism at an angle (here 6°) that is less than the power of the sector prism (10°) (by turning the head leftward while maintaining fixation at the perimeter's fixation target), the visual field of the hemianopia-side eye is split, with a segment shifted by the prism power towards the hemianopic side. It is assumed here that the left eye has maintained the fixation at the perimeter fixation target and that the patient remains orthophoric (and that fusion has not occurred, as discussed below). The width of that shifted segment is determined by the angle between the eye's visual axis and the prism apex (here 6°). That segment is separated from the rest of the hemianopia-side visual field by a prism scotoma that is the width of the prism power (10°). This split is the same as occurs with binocular sector prisms, except that with monocular sector prisms, the visual field of the seeing-side eye has not been shifted, so it partially overlaps the visual field of the prism scotoma, producing true visual field expansion in the binocular visual field. The visual field expansion is however accompanied by foveal double vision.[10, 11] Note the absolute scotoma between the prism-shifted hemianopia-side-eye and seeing-side-eye visual fields (here 4° wide). Such a scotoma in the binocular visual field was measured for that right hemianopic patient as shown in Fig. A2b. Her binocular visual field shows visual field expansion with the absolute scotoma separating the two visual field segments.

When viewing further into the monocular sector prism (15° in Fig. A1c), the visual field of the hemianopia-side eye is split again, with a segment that is the width of the eye movement (15°) moved by the prism power (10°) towards the hemianopic side. That segment is separated from the rest of

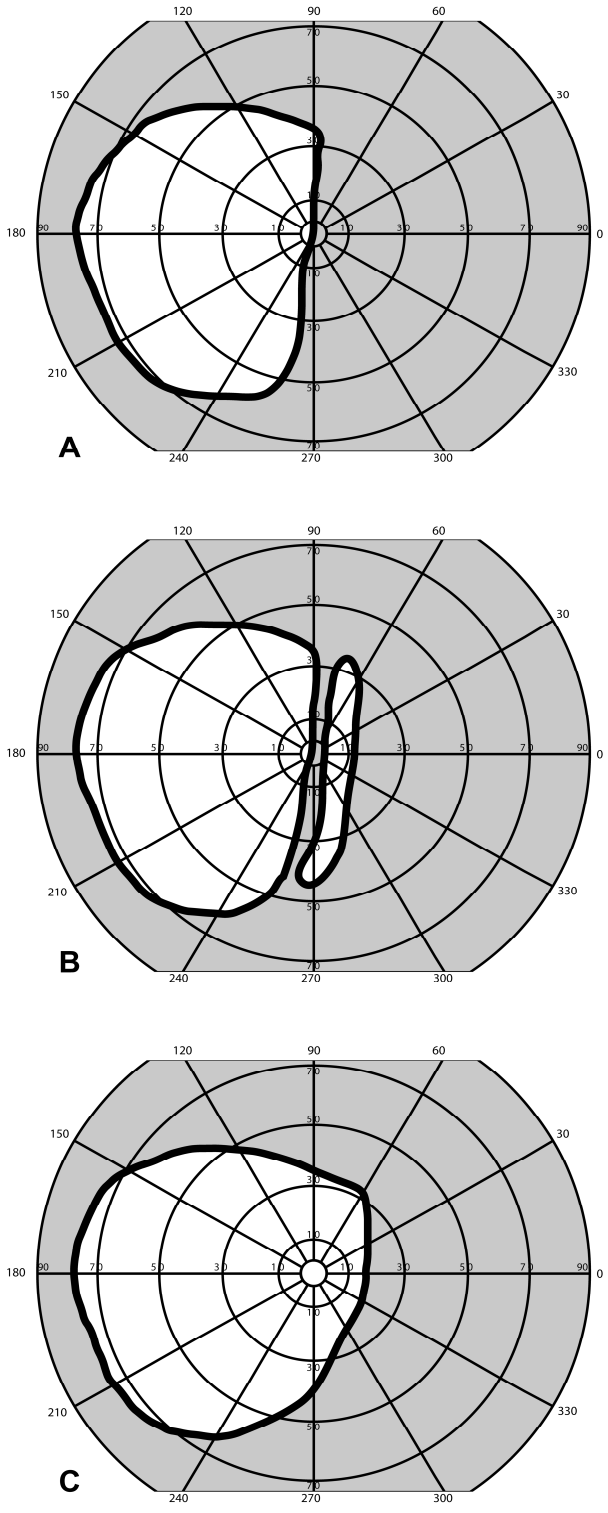

FIGURE A2.
Measured binocular visual fields of a patient with right hemianopia wearing a 9° monocular sector prism for the first time. **A**. Binocular visual field measured without the prism. The same field was measured when the patient was looking through the prism free part of the lenses. **B**. Binocular visual field measured with the patient looking slightly into the prism. This was achieved by tilting the head slightly to the left while maintaining fixation of the perimetry fixation target. A small visual field expansion to the right was recorded, together with a central optical scotoma (gap). **C**. With further shift of the gaze into the prism, visual field expansion with no gap was recorded. This visual field expansion is associated, however, with central double vision.

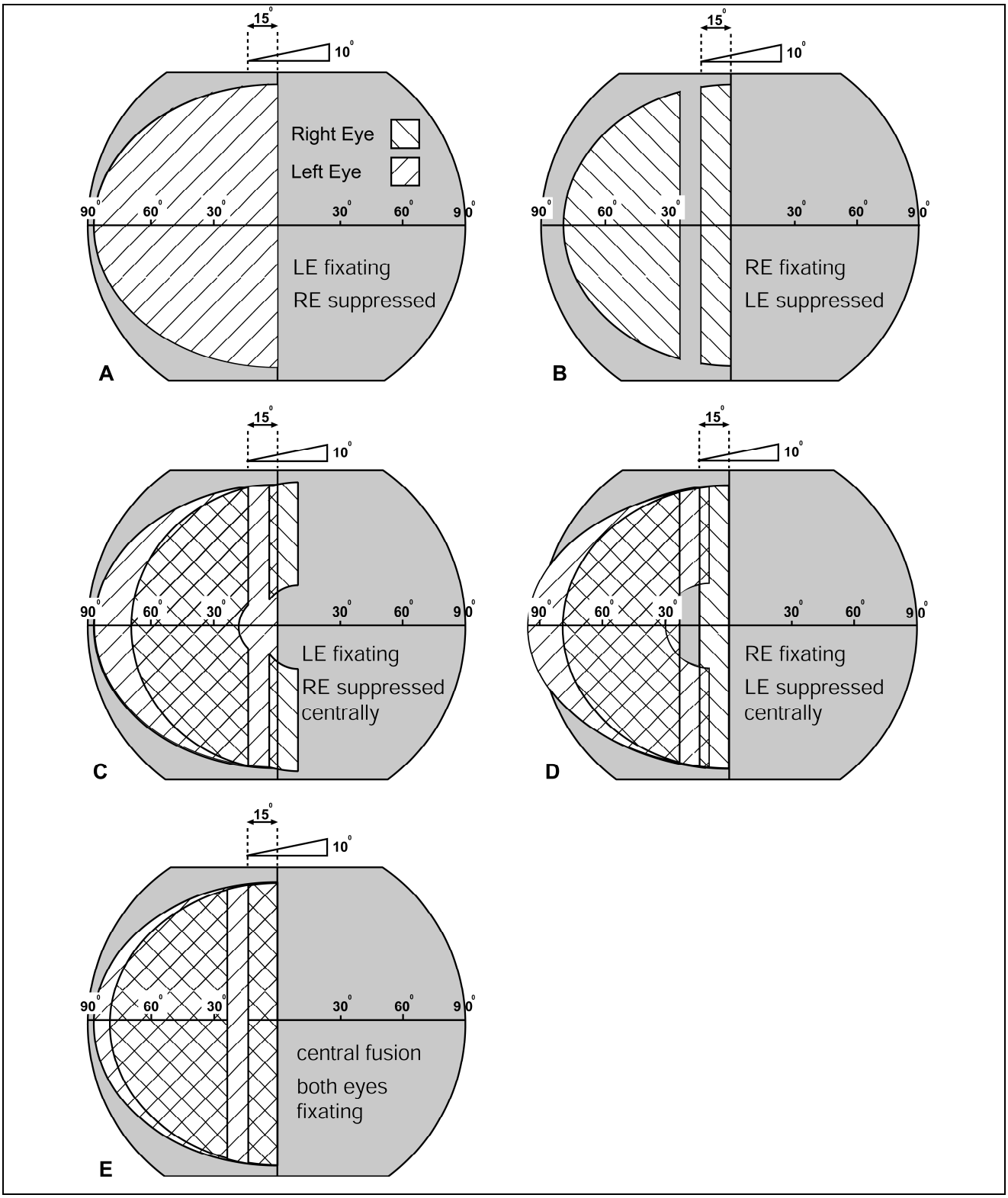

FIGURE A3
When, as reported,[11] the "momentary" double vision disappears, the various ways it may be eliminated result in different visual field outcomes. Here, too, it is assumed that the patient remains orthophoric. **A**. If the right eye is suppressed completely, the binocular visual field remains about the same as that recorded without prism as the left eye visual field is not affected by the right lens prism. **B**. If the left eye is suppressed completely, the visual field is reduced to the nasal visual field of the right eye. Note the prism scotoma and the lack of expansion into the blind hemifield, since the right eye takes up fixation. **C**. If only central vision of the right eye is suppressed (again the left eye is assumed to be fixating), the visual field will be expanded, above and below fixation, into the blind hemifield. In this case as well as in D the peri-central areas of binocular overlap represent areas of double vision. **D**. If only central vision of the left eye is suppressed, since the right eye takes up fixation, the visual field will be expanded to the left, but not into the blind hemifield. **E**. If the user is able to fuse the double images seen through the 10° prism, the effect of the prism on the binocular visual field is eliminated. Note the lack of expansion into the blind hemifield, since both eyes fixate the target.

the hemianopia-side-eye visual field by a prism scotoma that is the width of the prism power (10°). Since this prism scotoma completely overlaps with the seeing-side-eye visual field, there is no scotoma in the binocular visual field. In addition to the region of normal (physiological) peripheral double vision in the area of binocular overlap on the seeing side of the prism scotoma there is also a region of abnormal (prism induced) peri-central double vision on the hemianopic side of the prism scotoma (here 5° wide, abnormal because the double vision includes a prism shift of hemianopia-side information). Again, the visual field expansion is accompanied by foveal double vision. The measured binocular visual field of that right hemianopic patient (Fig. A2c) shows the expected visual field expansion.

Thus, a new wearer of a monocular sector prism can experience visual field expansion (Fig. A2) at the expense of foveal double vision (visual confusion rather than diplopia, since two objects will appear to have the same visual direction). Reportedly, this double vision is transient disappearing after some time.[11] For the double vision to disappear there must be either suppression or fusion. Suppression of the hemianopia-side eye is illustrated in Fig. A3a, which results in a binocular visual field that is essentially the same as the binocular visual field before use of the monocular sector prism, thus providing no benefit. Suppression of the seeing-side eye (Fig. A3b) would result in a visual field that is smaller than the binocular visual field before use of the monocular sector prism, since the hemianopia-side eye has only the nasal visual field. Suppression in such situations may be partial and may be limited to the central vision (here illustrated arbitrarily as 50° in diameter) of either the hemianopia-side eye (Fig. A3c) or the seeing-side eye (Fig. A3d), in which case, the binocular visual field would be expanded and there would be no foveal double vision. Similar to the peripheral prisms, the visual field expansion is on the blind side of the fovea in the case illustrated in Fig. A3c, but in the case illustrated in Fig. A3d the expansion is on the far periphery of the seeing side, which is far less valuable. Such field expansion effects, however, have not been reported. If such cases do occur, they will be accompanied by peri-central double vision and with a possible peri-central scotoma. The other alternative to eliminating the initial double vision is that the wearer uses fusional eye movements to overcome the foveal diplopia (Fig. A3e). This will result in no visual field expansion and a region of abnormal peripheral double vision on the seeing-side of the prism scotoma.

Thus, binocular visual field expansion can occur with a monocular sector prism, but, as yet, there is no evidence that this expansion can be retained once the wearer adapts to the monocular sector prism. The fleeting visual field expansion which takes place before suppression or fusion overcomes the double vision may be useful for the patients. However, that effect has not been demonstrated or measured.

In the peripheral prism case, the visual field expansion takes place at all positions of gaze. With the extension of the prism into the seeing hemifield the optical scotoma at the apices of the prism segments are usually covered by the vision in the fellow eye. The double vision that accompanies the visual field expansion in this case is restricted to the peripheral visual field and is therefore much easier to tolerate. Since binocular central vision is maintained through the prism-clear center of the lens, the peripheral double vision is not sufficient to induce fusion and thus the visual field expansion effect of prisms is constant and continuous. Peripheral suppression may be possible under these conditions and we are investigating whether this occurs.

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APPENDIX 2

The text of questions in the Quality of Life questionnaires that we hypothesized would be affected by the peripheral prism glasses. Patients rated the following questions in terms of perceived difficulty.

Question Number	National Eye Institute Visual Functioning Questionnaire[36-38] (NEI-VFQ-25)
7	Because of your eyesight, how much difficulty do you have finding something on a crowded shelf?
10	Because of your eyesight how much difficulty do you have noticing objects off to the side while you are walking?
14	Because of your eyesight how much difficulty do you have going out to see movies, plays or sports events?
15c	If currently driving: How much difficulty do you have driving during the daytime in familiar places?
20	I stay home most of the time because of my eyesight?
24	I need a lot of help from others because of my eyesight?
A2	How would you rate your eyesight now (with glasses or contact lens on, if you wear them), on a scale of from 0 to 10, where zero means the worst possible eyesight, as bad or worse than being blind, and 10 means the best possible eyesight?
A7	Because of your eyesight, how much difficulty do you have taking part in active sports or other outdoor activities that you enjoy (like golf, bowling, jogging, or walking)?
A11a	Do you have more help from others because of your vision?
A11b	Are you limited in the kinds of things you can do because of your vision?
A13	I don’t go out of my home alone, because of my eyesight?

Question Number	Independent Mobility Questionnaire[39] (IMQ)
1	Walking in familiar areas?
2	Walking in unfamiliar areas?
4	Moving about at work?
6	Moving about stores?
7	Moving about outdoors?
8	Moving about in crowded situations?
10	Moving about using public transportation?
13	Walking up steps?
14	Walking down steps?
15	Stepping onto curbs?
16	Stepping off curbs?
17	Walking through doorways?
24	Being aware of another person's presence?
25	Avoiding bumping into people?
26	Avoiding bumping into walls?
27	Avoiding bumping into head height objects?
28	Avoiding bumping into shoulder height objects?
29	Avoiding bumping into waist height objects?
30	Avoiding bumping into knee height objects?
31	Avoiding bumping into low lying objects?
32	Avoiding tripping over uneven travel surfaces?
33	Moving around in social gatherings?
35	Seeing cars at intersections?