Fresnel prisms improve visual perception in stroke patients with homonymous hemianopia or unilateral visual neglect

Peter W. Rossi, MD; Solomon Kheyfets, MD, PhD; and Michael J. Reding, MD

Article abstract—We randomly assigned 39 patients with stroke and homonymous hemianopia or unilateral visual neglect to treatment with 15-diopter plastic press-on Fresnel prisms (n = 18) or to serve as controls (n = 21). Baseline evaluations of visual perception and activities-of-daily-living (ADL) function were similar for both groups. After 4 weeks, the prism-treated group performed significantly better than controls on the following: (1) Motor Free Visual Perception Test; (2) Line Bisection Task; (3) Line Cancellation Task; (4) Harrington Flock's Visual Field Screener; and (5) Tangent Screen Examination. There was no significant difference in Barthel ADL assessment at 4 weeks. Thus, treatment with 15-diopter Fresnel prisms improves visual perception test scores but not ADL function in stroke patients with homonymous hemianopia or unilateral visual neglect.

NEUROLOGY 1990;40:1597-1599

Homonymous hemianopia (HHA) and unilateral visual neglect (VN) are common problems in the stroke population. At our institution, 31% of inpatients on the stroke rehabilitation service have either HHA or VN, a frequency similar to previous reports. Both HHA and VN have an adverse effect on functional outcome and represent major impediments to regaining independence. Although the patient may have adequate strength and coordination for ambulation, inattention to obstacles in the affected visual field can significantly impair walking and transfer safety.

There is no uniformly accepted treatment for either HHA or VN. A variety of optical aids are used to help patients compensate for their visual difficulties, and anecdotal reports describe their benefits. These include Fresnel prisms, wide-angle lenses, mirrors attached to the spectacle frame, and closed-circuit TV monitor systems. There are, however, no controlled trials of these optical aids for stroke patients. Plastic press-on Fresnel prisms are commercially available, inexpensive, easily applied, and appear to be the most promising aid presently available. The present study is a prospectively randomized controlled assessment of 15-diopter Fresnel prisms for treatment of HHA or VN after stroke.

Methods. Thirty-nine patients with either HHA or VN were recruited from an inpatient stroke rehabilitation unit. The diagnosis of stroke was based on the clinical history, neurologic examination, and neuroimaging study (either CT or MRI) in each case. HHA was defined as the inability to reliably detect a 1-cm red target on tangent screen examination in a homonymous field pattern. Subjects were seated 1 meter from the screen subtending an angle of 30° from the optical axis. The target was advanced from the periphery of the screen toward the fixation point until perceived by the subject. VN was defined as the inability to reliably detect bilateral tachistoscopically presented targets of standardized luminance, size, duration, and angle from midline using the Harrington Flock's Visual Field Screener (Test Plate Series III). The diagnosis of HHA represents a primary visual perception deficit and precludes the diagnosis of VN.

Patients with best-corrected visual acuity worse than 20/200 and those unable to comprehend and cooperate with visual field assessment were excluded. As part of the admission criteria for the stroke rehabilitation unit, patients were free of disabling cardiac, pulmonary, or rheumatologic problems that might have precluded rehabilitation efforts.

After informed consent, patients were randomly assigned to either receive 15-diopter Fresnel prisms or to serve as controls. Fifteen-diopter Fresnel prisms were selected based on pilot studies indicating that this was the greatest strength that was easily tolerated by patients. Plastic press-on Fresnel prisms were trimmed to fit on the inside of the patient's spectacle lenses. Each prism was cut to the shape of a half circle overlaying only the affected hemifield, with the base of the prism toward the affected field. For example, a patient with right HHA received the prisms (base towards the right) over the right half of each lens with the free margin of the prisms trimmed approximately 2 mm from mid-pupil to avoid interfering with macular vision. The intended effect of such application was to shift a peripheral image more towards the central retinal meridian (figure).

Patients wore the prisms for all daytime activities. Prism
were assessed using Student's t test for unpaired data with \(p < 0.05\) indicating statistical significance. Student's t test for paired data was used to compare response variables within groups over time. Chi-square analysis was used to analyze tangent screen examination results and categorical demographic data.

**Results.** No significant differences were found between control and prism-treated groups in sex ratio, interval poststroke, lesion type, side of stroke, type of visual deficit, or Modified Mini Mental Status Examination results (table). The majority of patients in each group had cerebral infarction, and right hemispheric lesions were more common than left. The prism group was older than the control group (\(p < 0.01\)).

At baseline, both the prism-treated group and control group had similar MVPT response behavior in the affected visual field (53.2 ± 8 SEM vs 47.7 ± 6 SEM, respectively). By the end of 4 weeks, the prism-treated group had improved significantly (80.8 ± 4 SEM, \(p < 0.01\)) relative to baseline and in comparison with controls (65.9 ± 6 SEM, \(p < 0.01\)). No significant change was noted in the control group at 4 weeks relative to baseline.

Both the prism and control groups had similar Line Bisection error scores at baseline (2.3 ± 0.7 SEM vs 2.2 ± 0.5 SEM, respectively). No improvement was noted among control patients over time, whereas prism-treated patients improved by the end of 4 weeks relative to baseline (0.68 ± 0.2 SEM, \(p < 0.03\)) and to controls (2.2 ± 0.5 SEM, \(p < 0.01\)).

Similar results were found in the Line Cancellation Task errors at baseline (prism group 15 ± 3 SEM; control group 12.8 ± 3 SEM). Controls failed to improve over time, while the prism-treated group improved at 4 weeks relative to baseline (2.4 ± 1 SEM, \(p < 0.01\)) and to controls (9.8 ± 2 SEM, \(p < 0.02\)).

Harrington Flocks Visual Screener error scores were similar for the prism and control groups at baseline (17.5 ± 2 SEM and 21.2 ± 2 SEM, respectively). Both groups showed significant improvement from baseline at 2 weeks (8.7 ± 1 SEM and 17.6 ± 2 SEM, respectively, \(p < 0.01\)) and again at 4 weeks (5.8 ± 1 SEM and 14.2 ± 2 SEM, respectively; \(p < 0.01\)). Improvement among prism-treated patients surpassed that of controls at 4 weeks (\(p < 0.01\)).

Fifteen of 16 prism-treated patients showed expan-
sion of their visual field on Tangent Screen Examination at 4 weeks relative to baseline compared with 7 of 17 control patients ($q^2 = 8.02, p < 0.01$). The expansion in visual fields was assessed qualitatively as described in the Methods section above. The 2 patients with prisms and the 5 controls without repeat Tangent Screen Examination testing were not retested because of scheduling problems.

Among patients who received prisms, those with HHA performed consistently worse than those with VN. This was true for each of the visual perception tasks, though the difference did not reach statistical significance. Patients with either HHA or VN who were treated with prisms showed equal improvement at 2 and 4 weeks compared with baseline scores.

No significant difference in Barthel ADL scores was found between groups at any study interval. Both groups demonstrated improved ADL function relative to their initial evaluation (prism group 37 $\pm$ 5 SEM baseline and 50 $\pm$ 5 SEM at 4 weeks, $p < 0.01$; control group 42 $\pm$ 6 SEM baseline and 54 $\pm$ 5 SEM at 4 weeks, $p < 0.01$). The number of falls during the study interval was similar for both the prism (4 of 18) and control (4 of 21) groups.

Discussion. This study documents the utility of 15-diopter prisms for improving visual perception following stroke. Subjects adapt to the use of prisms within a day or two. The steady improvement in perceptual task performance over 4 weeks seems to indicate a more complex response to the prisms than simple adaptation. Previous studies suggest that the loss of vision within a hemianopic field is not absolute. Although patients may deny the conscious perception of visual information within the hemianopic field, it can be demonstrated that thresholds exist for detecting the presence or absence of a stimulus or stimulus movement within the hemianopic field. These thresholds are decreased for targets that are placed closer to the midline within the hemianopic field. The prismatic displacement of a peripheral image to a more central area of the retina may increase the likelihood that the image is perceived as "important" information requiring further visual exploration either by a change of gaze or with head rotation. Prisms may thus serve as a simple alerting device, drawing attention to the affected field, stimulating the patient to explore the area with the intact visual field. We have not determined whether the beneficial effect of prisms is sustained after they are discontinued. Although the study was not performed in a "blinded" fashion, we discount significant observer bias in the outcome data since there was uniform improvement of prism-treated patients even on tests that are relatively free of observer input. Tests such as the Line Bisection Task and Line Cancellation Task are relatively resistant to observer bias because of their simplicity. Tasks that require lengthy instruction and frequent monitoring by the examiner, such as the MVPT and Harrington Flocks Visual Screener, are more prone to examiner bias. The prism group outperformed the control group on all visual perception tasks irrespective of degree of observer involvement.

Improvement in visual perception test scores did not generalize to improvement in ADL and mobility function as measured by the Barthel score. Barthel scores for both control and prism-treated patients improved during the course of this study, but this improvement did not differ between groups. The Barthel score is an assessment of basic self-care and mobility functions, and may be insensitive to subtle improvement in visual perception.

We interpret our data to indicate that 15-diopter Fresnel prisms may be of benefit to stroke patients with HHA or VN. Additional controlled studies are needed to confirm our results and to define the optimal prism strength, manner of application, and duration of benefit.

References