Evaluating the Effects of Homonymous Hemianopsia on Mobility: Considerations from a Case Series

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Abstract

Homonymous hemianopsia is a significant visual impairment associated with stroke and traumatic brain injury. This bilateral loss of visual field to one side impacts one’s quality of life and ability to ambulate safely through the everyday environment. Rehabilitation providers seek evidence-based treatment strategies for improving the mobility of patients with homonymous hemianopsia. This case series of individuals with homonymous hemianopsia explores the effectiveness of prism, orientation and mobility, and visual scanning training.

Keywords: homonymous hemianopsia, mobility, prism

Introduction

Homonymous hemianopsia (HH) is a significant visual impairment that can be associated with cerebral vascular accident (CVA) and traumatic brain injury (TBI). It is estimated that 795,000 Americans have a new or recurrent stroke each year (American Heart Association, 2010). Consequentially, as many as a third of these experience HH or hemi-neglect (Pambakian & Kennard, 1997). Bruce, Zhang, Kedar, Newman, and Biousse (2006) reported that 12 percent of patients with TBI were found to have HH.

The classic functional effect of HH is that the lateral visual field in one direction is absent in both eyes (e.g., to the left, to the right). HH causes significant difficulty with activities of daily living including reading (Trauzettel-Klosinski & Brendler, 1998) and mobility (Salive, 1994; Zihl, 1995). Persons with HH are unable to drive legally (Szlyk, Brigell, & Seiple, 1993; Szlyk, Seiple, Stelmack, & McMahon, 2005). In addition, these individuals are at significant risk for accident and secondary injury (Nooney, 1986; Rapport et al., 1993; Webster & Abadee, 1995). Although recovery of vision is sometimes seen following stroke or brain injury, after several months visual-field recovery becomes rare (Zhang, Kedar, Lynn, Newman, & Biousse, 2006). Therefore, development of compensatory strategies plays an important role (Zihl, 1995).

Previous studies have demonstrated that mobility problems are common in individuals with HH (Zihl, 1995, 1999) and include difficulty detecting people, obstacles, and locations (Laderman, Szlyk, Kelsch, & Seiple, 2000); avoiding obstacles and people (Zihl, 1999); and ability to travel safely (Mancil et al., 2005). Relatively few rehabilitation strategies and devices have been developed to improve mobility in this population.
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Walking speed measurements have been used to quantify mobility performance in individuals with visual impairment. Attempts have been made to correlate walking speed with the amount of remaining vision in order to determine which clinical tests best predict mobility performance (Dodds, Carter, & Howarth, 1983; Geruschat & De l’Aune, 1989; Hollyfield & Trimble, 1985). The Percentage of Preferred Walking Speed (PPWS), introduced by Clark-Carter, Heyes, and Howarth (1986), is the percentage expressing the ratio of real-world walking speed to the ideal speed that individuals would walk if they were normally sighted. PPWS has been used previously in numerous studies and has been shown to correlate with clinical measures of residual vision and mobility (Beggs, 1991; Geruschat, Turano, & Stahl, 1998; Hartong, Jorritsma, Neve, Melis-Dankers, & Kooijman, 2004; Hassan, Lovie-Kitchin, & Woods, 2002; Haymes, Guest, Heyes, & Johnston, 1996; Jones & Troscianko, 2006; Mancil et al., 2005; Patel et al., 2006; Turano, Geruschat, Stahl, & Massof, 1999). In the Salisbury Eye Evaluation, Patel et al. (2006) described the association between reduced visual field and reduced mobility using PPWS.

Optical therapy for HH patients involves prescribing prisms and training in visual scanning strategies in order to use remaining vision to travel more safely (Pambakian & Kennard, 1997). Some have proposed that patients with HH who regain awareness of their environment may experience a reduced period of convalescence and that their risk of secondary injury may be lessened (Nooney, 1986). Despite their frequent use, the techniques involved in optical and eye movement rehabilitation for HH have not undergone rigorous evaluation, and these treatments are inconsistently applied. Only a few small-scale studies have evaluated the effectiveness of common prism treatments (Giorgi, Woods, & Peli, 2009; Gottlieb, Freeman, & Williams, 1992; Peli, 2000).

An additional experimental rehabilitation technique known as visual field restitution involves the practice of detecting stimuli with the blind field. Various techniques have been utilized to explore the visual system’s potential for neuroplasticity, and research in this area has been summarized recently by Schofield and Leff (2009). Visual field restitution is not yet a commonly applied rehabilitation technique and warrants further study.

In addition to impaired mobility, reading disability is common with HH (Trauzettel-Klosinski & Brendler, 1998). Severely reduced reading speeds have been associated with reduced reading-related quality of life measures in this population (Gall, Wagenbreth, Sgorzaly, Franke, & Sabel, 2010).

Design of a Case Study

A record review identified five patients with complete HH who were ambulatory and who had not previously been prescribed a prism system.1 A group of 12 participants with normal sight and normal walking mobility were identified to complete the same measures for comparison purposes. The study protocol was reviewed, approved, and monitored by the Hefner VA Medical Center Institutional Review Board. Medical clearance was obtained from each participant’s primary care provider, and all participants completed an informed consent process. Each participant was required to be ambulatory with walking mobility (i.e., a support cane or walker was allowed but a wheelchair was not).

Participants completed the Mini Mental State Examination (MMSE) and Beck Depression Inventory (BDI-II). The required score was at least 50 out of 57 on the MMSE (indicating the participant was cognitively intact) and lower than 20 with the BDI-II (higher scores indicate moderate or severe depression) (Beck, Steer, & Brown, 1996; Beck, Steer, & Garbin, 1988). Each participant completed these evaluations and met these requirements. Unilateral spatial neglect (USN), a failure to attend and respond to stimuli, sometimes occurs after CVA and may coexist with homonymous hemianopsia (Bowen, McKenna, & Tallis, 1999; Heilman & Valenstein, 1993). USN was excluded for each HH participant.

1The study group reviewed records and identified 48 unique patients with a diagnosis of homonymous field loss who were examined within the past 3 years. After review, only five patients were identified as potential participants. A majority of patients identified with complete hemianopsia were not ambulatory and had significant comorbidities that excluded their participation. Transportation to and from research appointments also limited participation because persons with hemianopsia are not legally able to drive in North Carolina.
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using free drawing, copying, and line cancellation (Schenkenberg, Bradford, & Ajax, 1980) testing.

Measures of vision for each participant were obtained including Snellen visual acuity and Humphrey Matrix perimetry. Adopted walking speed testing was completed using outdoor routes previously used by Mancil et al. (2005). The routes are 200 meters in length and incorporate one turn and one street crossing. Survey data were collected using two validated instruments designed for this population: Veterans Affairs Low-Vision Visual Functioning Questionnaire (VA-LV-VFQ) (Stelmack et al., 2006) and the Independent Mobility Questionnaire (IMQ) (Turano et al., 1999). The VA-LV-VFQ, according to Stelmack et al. (2006), "was designed to measure the difficulty visually impaired persons have in performing daily activities and to evaluate vision rehabilitation outcomes" (p. 3,253). The IMQ was created originally as a tool to measure independent mobility in patients with retinitis pigmentosa (Turano et al., 1999) and has since been validated for use with glaucomatous vision loss (Turano et al., 2002). Reading speed measures were obtained using MN Read text and the I-Scan eye movement monitoring system (ISCAN, Inc., Woburn, MA).

Those with HH were randomly assigned to receive either (a) lateral prism placement (i.e., traditional Fresnel press-on prism placement; see Figure 1) or (b) expansion prism placement (i.e., Peli’s horizontal expansion prism lens placement; Peli, 2000; see Figure 2). After initial vision and mobility testing, HH participants were seen by a low-vision optometrist for prism fitting and instruction and underwent visual skills/visual scanning training using the prism device (based on Laderman et al., 2000, and Szlyk et al., 2005). They received mobility training that involved walking with the device and practice with obstacle detection while walking and using the device. Participants were assigned 1 week of home-practice indoor and outdoor mobility activities at the conclusion of the first visit. Each participant was contacted by phone within the first week to verify compliance with the prism device and mobility practice tasks.

Each HH participant was seen again from 7 to 14 days later, at which time visual skills/visual scanning training and additional mobility training while wearing the prisms were repeated, and each participant was again assigned 1 week of home-practice exercises. One to two weeks later, each HH participant was seen for a final visit to obtain postintervention walking speed measurements, reading speed measurements, and postintervention surveys.

Case Presentations

Participant 1 is a 49-year-old woman who experienced right HH after CVA 2 years previously. Her best corrected visual acuity was 20/20 in the right eye, 20/20 in the left eye. Her initial outdoor walking speed was 1.70 meters per second, and reading speed was 173.31 words per minute. She reported difficulty with 14 mobility-related activities of daily living addressed with IMQ. The greatest difficulty was identified as adjusting to lighting changes, both indoor to outdoor and outdoor to indoor. She was fitted with a Peli prism system and completed the three clinic visits and home training.

At her third visit, her outdoor walking speed measured 1.78 meters per second. Her reading speed measured 246.09 words per minute. Of the 14 areas of difficulty originally reported with IMQ, improvement was noted in 13 areas. At the conclusion of this visit she rated her mobility as very much improved and indicated that she will continue to use the prism device.

Participant 2 is a 58-year-old man who experienced left HH after CVA 3 years previously. His best corrected acuity was 20/30 in the right eye, 20/80 in the left eye. His initial outdoor walking speed was 1.27 meters per second, and reading speed measured 183.94 words per minute. Difficulty was reported with 26 mobility-related activities of daily living addressed with IMQ. The most significant areas of difficulty were walking in unfamiliar areas, seeing cars at intersections, avoiding bumping into knee-high objects, avoiding bumping into low-lying objects, stepping onto curbs, stepping off curbs, moving about in crowded situations, and moving about in stores. He was fitted with a Peli prism system and completed the three clinic visits and home training.

At his final visit, his outdoor walking speed measured 1.24 meters per second. His reading speed measured 195.05 words per minute. Of the 26 areas of difficulty reported with IMQ, improvement was noted in 23 areas. At the conclusion of this visit he rated his mobility as somewhat improved and
Participant 3 is a 58-year-old man who experienced left HH after CVA 5 years previously. His best corrected acuity was 20/25 in the right eye, 20/20 in the left eye. His initial outdoor walking speed was 1.61 meters per second, and reading speed measured 133.95 words per minute. Difficulty was reported with 16 mobility-related activities of daily living addressed with IMQ. His areas of greatest difficulty were identified as walking in unfamiliar areas, moving about in crowded situations, walking at night, and avoiding bumping into people. He was fitted with a traditional prism system and completed the three clinic visits and home training.

At his final visit, his outdoor walking speed measured 1.62 meters per second. His reading speed measured 118.42 words per minute. Of the 16 areas of difficulty reported with IMQ, improvement was noted in 14 areas. At the conclusion of this visit he rated his mobility as somewhat improved and indicated that he will continue to use the prism device.

Participant 4 is a 47-year-old man who experienced right HH after CVA 10 years previously. His best corrected visual acuity was 20/20 in the right eye, 20/20 in the left eye. His outdoor walking speed was 1.76 meters per second, and reading speed measured 234.11 words per minute. With IMQ he reported difficulty with 18 mobility-related activities of daily living. Most significantly, he reported difficulty when moving about in crowded situations, avoiding bumping into knee-high objects, and avoiding bumping into low-lying objects. He was fitted with a traditional prism system and completed the three clinic visits and home training.

At his final visit, his outdoor walking speed measured 1.62 meters per second. His reading speed measured 279.26 words per minute. Of the 18 areas of difficulty reported with the IMQ, improvement was noted in 15 areas. At the conclusion of this visit he rated his mobility as very much improved and indicated that he will continue to use the prism device.

Participant 5 is a 53-year-old male who experienced right HH after CVA 5 years previously. His best corrected visual acuity was 20/25 in the right eye, 20/20 in the left eye. His initial outdoor walking speed was 1.58 meters per second, and reading speed measured 70 words per minute. He reported difficulty with four mobility questions addressed with IMQ. The most significant area of difficulty identified was being aware of another person's presence. He was fitted with a traditional prism system and completed the three clinic visits and home training.

At his final visit, his outdoor walking speed measured 1.78 meters per second. His reading speed measured 117 words per minute. Of the four areas of difficulty reported with the IMQ, improvement was noted in one area. At the conclusion of this visit he rated his mobility as very much improved and indicated that he will continue to use the prism device.
Discussion

The mean age of the HH participants (N = 5) was 53 years. The mean age of the participants with normal sight (N = 12) was 49.25 years. In this study, participants with normal sight walked outdoors at an average rate of 1.85 meters per second (standard deviation = 0.144) compared with HH participants' speed of 1.58 meters per second (standard deviation = 0.144) (p = .01). After intervention, HH participants improved to 1.63 meters per second (standard deviation = 0.176) (p = .222). Although four out of five HH participants walked faster after training, this improvement is not statistically significant (note the small sample size).

Participants with normal sight reported no difficulty with all 32 scored mobility questions addressed by the IMO. The HH participants stated they had difficulty with 31 out of the 32 questions, reporting the highest levels of difficulty with (a) walking in unfamiliar areas; (b) moving about in crowded situations; (c) being aware of another person's presence; (d) avoiding bumping into people; (e) avoiding bumping into shoulder high objects; (f) avoiding bumping into knee high objects; and (g) avoiding bumping into low lying objects.

Participants with normal sight reported no difficulty with questions from the VFO-48 survey.

The HH participants all reported difficulty in each of the five subject categories (i.e., visual ability, visual information, reading, visual motor, and mobility), with the largest disparity noted in the scoring of visual information processing. After training, HH participants had scores that indicated less difficulty in each of the five categories, but they still reported having greater difficulty than normal participants. The HH patients reported their overall mobility to be either somewhat improved (N = 2) or significantly improved (N = 3). Each participant chose to continue to wear the prism device.

Mean reading speed for participants with normal sight was 226 words per minute (standard deviation = 36.4), significantly faster than the HH patients' 159 words per minute (standard deviation = 61.3) (p = .029). After intervention, HH patients improved reading speed to 191 words per minute (standard deviation = 73.5) (p = .106), but this improvement was not statistically significant (note the small sample size).

Conclusion

Those with HH walk significantly slower than individuals with normal sight in the everyday environment. Based on survey measures, the interventions applied for HH led to improvement in perceived difficulty with mobility. Areas of greatest improvement were observed to be the following: walking in unfamiliar areas; moving about in crowded situations; being aware of another person's presence; avoiding bumping into people; and avoiding bumping into shoulder-high, knee-high, and low-lying objects. At the conclusion of the training visits, all HH participants reported their mobility to be improved, and each indicated he or she would continue to use the issued prism device.
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Based on our experience with these patients, we recommend that individuals with HH be evaluated with an optical prism combined with visual skills and mobility training. Participants responded positively to these interventions, and each perceived improved mobility at the study’s conclusion. This pilot project was limited by the small sample size, despite efforts over several months to identify and enroll qualified participants. Although the cases reported and trends suggested have application to other individuals with HH, the small sample size did not provide for statistical significance with these findings. In order to obtain statistically significant results, any further study of mobility in this population will need to address difficulties related to transportation, confounding comorbidities, and previous use of prism. Furthermore, additional strategies may warrant investigation, including other approaches to fitting prisms, different types of prism systems, visual scanning training, orientation and mobility training, and combinations of these interventions. Additional evidence gathered from randomized and controlled trials would be of great value to patients with HH who, as shown in this project, face unique difficulties with mobility and independence.

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References
