Article

Common Occupational Therapy Vision Rehabilitation Interventions for Impaired and Low Vision Associated with Brain Injury

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ABSTRACT

Background: Visual impairments secondary to traumatic brain injury (TBI) may include loss of acuity or visual field, convergence insufficiency, divergence insufficiency, strabismus, oculomotor dysfunction, or accommodative dysfunction. Neuro-ophthalmologists, neuro-optometrists, and occupational therapists recognize the need for interprofessional visual rehabilitation following traumatic brain injury. This study identified common and current vision rehabilitation interventions utilized by occupational therapists for individuals with traumatic brain injury.

Methods: A quantitative cross-sectional design was used to survey occupational therapists; thirty five (N=35) participants recruited from hospitals and rehabilitation facilities met the inclusion criteria.

Results: One hundred percent of participants use compensatory strategies to address impaired visual acuity and visual field deficits; 100% of participants use neuroplasticity theory-based interventions for visual field deficits, 94.3% for oculomotor deficits, and 91.4% for impaired visual acuity.

Conclusions: Results indicate that compensatory strategies are the most common intervention used by occupational therapists to address visual impairments secondary to TBI, followed by neuroplasticity theory-based interventions. Evidence supports the effectiveness of compensatory strategies following assessment and consultation with neuro-ophthalmologists or neuro-optometrists.

Keywords: occupational therapy, vision rehabilitation, traumatic brain injury, visual impairments

Introduction

Neurologists, neuro-ophthalmologists, neuro-optometrists, optometrists (OD), physicians, and occupational therapists (OT), recognize the need for visual rehabilitation following traumatic and acquired brain injury. Doctors of optometry and OTs collaborate to provide interprofessional intervention for impaired vision. The OD addresses ocular pathology, anatomical changes that interfere with information getting to the retina. ODs also provide rehabilitation and prescribe technology for vision disorders associated with neurological sequelae and low vision dysfunction. Recently, OTs have increased their role in providing primary intervention for visual rehabilitation. Therapists provide compensatory strategies, assistive technology, and neuroplasticity-based theoretical methods to remediate visual deficits.[1] Compensatory strategies for decreased visual acuity may include altering lighting, providing contrast, and/or magnification. Prisms, training in scanning techniques, or patching may be used for diplopia or impaired visual fields.[2]

Today neuroscientists, ODs, and OTs support the neuroplasticity theory of brain and vision interaction and recovery. Neuroplasticity is based on the theory that the brain has the ability to form new neural pathways throughout life.[3] Neuroplasticity is defined as the brain's ability to modify itself and to form new circuits in order to support function or changes that enhance existing synapses in the support of vision. Neuro-optometrists and pioneers of neuroplasticity suggest that vision provides information for learning; movement develops vision; vision serves as a substitute for movement; vision is driven by motor pursuits; and vision allows us to derive meaning and formulate a decision and direction of action.[4,5] Functional vision is dynamic and requires the interaction of subcortical and cortical structures such as the occipital lobe and multiple visual pathways. Disruption of these pathways results in altered visual processing and changes in functional behavior.[4-6]

Occupational therapists work in partnership with neuro-ophthalmologists and neuro-optometrists across various practice settings (acute, inpatient, outpatient, and skilled nursing) to provide interventions for individuals with a traumatic or acquired brain injury (TBI or ABI). Occupational therapists strive to improve quality of life by engagement in purposeful activities.[7] A high prevalence of individuals with TBI could benefit from occupational therapy and vision rehabilitation services.[8] Several well-known textbooks, such as Radomski and Trombly Latham,[9] Pedretti and Early,[10] and Gillen[11] focus on visual rehabilitation. Warren[12] and Scheiman[2] have also developed theoretical concepts and interventions. While the content of these resources offer interventions for visual dysfunction, little is known about the most common and current interventions used by occupational therapists to address visual dysfunction for TBI. (http://bit.ly/2fdvjFf – Occupational Therapy Services for Persons with Visual Impairment [AOTA])

The purpose of this study was to explore occupational therapists' use of interventions for individuals with TBI and visual dysfunction. By examining the use of various vision intervention methods, dissemination of results may lead to implementation of evidence-based interventions. We hypothesized that the most frequently selected vision rehabilitation methods currently used by occupational therapists would be compensatory strategies, followed by optical devices and then neuroplasticity theory-based interventions.

TBI with visual impairment is a growing public health problem. Of the 1.7 million TBI cases diagnosed annually, over 60% will have visual deficits.[13,14] Visual impairments significantly influence an individual's ability to perform activities of daily living (ADLs) and instrumental activities of daily living (IADLs), as well as their participation in meaningful occupations.[15-19] The inability to see completely and clearly is a common result of damage to the brain.[20] Visual impairments or low vision secondary to TBI or ABI may include visual acuity, visual field loss, convergence insufficiency, divergence insufficiency, strabismus, oculomotor dysfunction, and accommodative dysfunction.[13, 21-29]

The manifestations of these impairments depend on the impact of the injury and the lobes of the brain involved. Researchers suggest that following a coup-contrecoup impact associated with an acceleration or deceleration injury, brain tissue may be bruised or sheared, resulting in a focal or diffuse injury. Injuries to the brain often result in secondary sequelae that is described with varying terminology. ODs refer to ventral stream, dorsal stream, or transient v. sustained or magnocellular v. parvocellular pathways. OTs attribute visual processing to the occipital lobe and northern and southern routes.[12] The northern route processes visual information from the occipital lobe, parietal, and prefrontal lobes. This route synthesizes information from all sensory systems (i.e., tactile, vestibular, and proprioceptive), creates an internal map, orients the body in space, and supports spatial relationships (e.g., recognizing objects around the body).[12] Information from the southern route travels from the occipital to the temporal and prefrontal lobes. It is through this route that information is transferred from the fovea (macula) to the retina and is processed into visual object recognition, color, and form. Humans identify, classify objects, attend to detail, and distinguish discrete features (e.g., diet coke can from regular) and facial features.[12]

When both routes are involved, the visual hierarchy is significantly compromised.[12] Individuals experience altered visual acuity, visual fields, oculomotor control, visual attention, visual scanning, visual pattern recognition, visual memory, and visuo-cognition (the highest level of visual processing). If the image is distorted when it falls on the retina, this will negatively impact all of the other levels of the hierarchy.[30] For example, diplopia or double vision may interfere with acuity when reading text. Visual field deficits impede perception and processing of information from the periphery. Reduced ocular motility associated with dysfunction in cranial nerves III, IV, and VI hinder vertical and horizontal eye movements needed for smooth pursuits and saccades.[31] Thus, individuals will have difficulty engaging in occupations such as reading, driving, and education or leisure tasks. Lack of visual attention reduces safety in a moving or fixed environment, which requires maneuvering around stationary or moving objects, respectively. Inability to attend to detail or important features hinders recognition of patterns and shapes and the global make-up of the environment. Visual memory depends on accurate recognition of patterns; features are stored in visual memory to aid in recall and decision-making.[31] For example, a visual search is initiated to recall where the cell phone may be located. Visual cognition completes the hierarchy and supports all previous levels. Individuals with a TBI, ABI, or low vision may have poor acuity and scanning, ocular motility, and ill-sustained attention, which will hinder higher level visual processing, formulating a plan, problem-solving, and making decisions.[31]

Vision Therapy in Action (Used with Permission of the Excel Institute of Shelby)

Methods

Research Design

The study design used a quantitative, cross-sectional survey to determine types of interventions currently and most commonly used by occupational therapists. The use of this approach expands the ability to gather data through a non-invasive method, allowing for greater accessibility.[32] Institutional Review Board approval for this research study was obtained before data collection.

Participants

Licensed OTs providing therapeutic services to individuals who have had TBI, ABI, or low vision in the State of Nebraska were targeted for participation in the study. Participants were recruited from 10 sites located throughout

Nebraska; prior permission was received from the employers. Eight of these sites agreed to participate in the research study. We arranged a time to deliver approximately 75 hard copies of both the informed consent and survey. Thirty-six completed our survey and 35 met our inclusion criteria. One participant completed the survey but was excluded due to not providing services to persons with TBI.

Procedures

We developed a 23-item paper-pencil survey based on a comprehensive literature review. The literature identified vision rehabilitation strategies most frequently implemented by occupational therapists for persons with visual impairments as a result of TBI. The questionnaire was piloted with three licensed occupational therapists with a minimum of three years of practice to determine clarity, relevance, and significance to current practice. Questions in the survey were modified based on therapists' feedback. Survey question format included a combination of closed-ended, multiple choice, check-all-that-apply, and Likert scale questions. Questions addressed demographic information including area of practice, years of practice, location of practice, and services provided for vision intervention. Participants were asked to identify for which vision impairments they provided intervention and which screenings were used most often. Twelve closed-ended, check-all-that-apply questions were used to determine which interventions were used most frequently and for which areas of occupation they provided intervention. The last three questions sought to determine the frequency with which occupational therapists refer or consult with optometrists, neuro-ophthalmologists, and ophthalmologists to improve visual perceptual outcomes for patients with TBI.

A time was scheduled to deliver and to pick up the completed surveys. The surveys were delivered to the rehabilitation department of the selected facilities (such as staff therapist, research administrator, or manager of the department). Hand delivery of the surveys ensured understanding of the purpose of the study, the terms of the survey, the process to complete the survey proficiently, and the timeline for completion. Informed consent was obtained prior to completing the survey and stated that participants could stop taking the survey at any point. Participants were also provided the Bill of Rights for Research Participants. Each site had up to three weeks to complete the surveys.

Data Analysis

Data analyses were conducted by IBM Statistical Package for Social Science (SPSS) version 21.[33] Descriptive statistics were computed to determine frequencies and percentages of the most common intervention methods based upon visual impairments; these included optical devices, compensatory methods, and neuroplasticity-based methods. Frequencies and percentages were also performed on visual acuity, visual field impairments, and oculomotor deficits as these were the main visual impairments examined. Descriptive statistics quantified demographic information, such as location or site in which the participant was employed, number of practice years, and practice setting in which the interventions were utilized.

Results

Participant Demographics

Of 35 participants, 34 were licensed in the state of Nebraska, and one was licensed in both Nebraska and Iowa. The two most common practice settings identified were acute care and inpatient rehabilitation. Twenty-three percent of participants did not affiliate themselves with a particular practice setting; therefore, we identified them as unknown. Fifty-one percent of our participants had <4 years of practice experience; 26% had 5-10 years; 11% had 10-15 years; and 11% had >15 years of practice experience.

Table 1. Interventions for Impaired Visual Acuity

Optical Device	No. of Responses (%)	Compensatory Strategies	No. of Responses (%)	Neuroplasticity-Based Interventions	No. of Responses (%)
Hand-held magnifiers	23 (65.7%)	Enlarged print	32 (91.4%)	Computer retraining	3 (8.6%)
Stand magnifiers	5 (14.3%)	Enlarged objects	21 (60.0%)	Relaxation techniques	3 (8.6%)
Spectacle magnifiers	41 (1.4%)	High-contrast background	26 (74.3%)	Visualization techniques	7 (20.0%)
Telescopes	0 (0.0%)	Increase light	24 (68.6%)	Visual scanning training	29 (82.9%)
Electronic magnifiers	5 (14.3%)	Non-glare paper or yellow acetate	7 (20.0%)	Flashlight exercise	6 (17.1%)
Max detail clip	0 (0.0%)	Motion lights	2 (5.7%)	Near-far focus shift	19 (54.3%)
Around-the-neck Magnifier	2 (5.7%)	Task lighting	13 (37.1%)	Action video games	2 (5.7%)
Easy pocket	1 (2.9%)	Computer software with zoom lens capabilities	7 (20.0%)	None	3 (8.6%)
Ruby Magnifier	2 (5.7%)	Different colors for better contrast	19 (54.3%)		
Spectacle magnifier	2 (5.7%)	Black-on-white or white-on-black print	20 (57.1%)		
Filters or absorptive lenses	3 (8.6%)	Solid colors for items	12 (34.3%)		
None	8 (22.9%)	Decreased clutter in the environment	29 (82.9%)		
		Bright colors on/for stairs, doors, labels	18 (51.4%)		
		Home modifications	26 (74.3%)		
		Scanning the environment	31 (88.6%)		
		None	0 (0.0%)		

*Note. Results were from "check all that apply" question.

Data analysis focused on answering the following question: What are the most common vision therapy techniques, specifically optical devices, compensatory strategies, and neuroplasticity theory-based interventions, implemented by current occupational therapists to improve occupational performance of individuals who have experienced visual impairments as a result of a TBI?

Most Common Interventions for Impaired Visual Acuity

Concerning impaired visual acuity, participants reported using optical devices, particularly hand-held magnifiers (65.7%), stand magnifiers (14.3%), and electronic magnifiers (14.3%) as intervention methods (Table 1). We also inquired about compensatory strategies used to address impaired visual acuity. The results showed participants to utilize enlarged print (91.4%), scanning the environment (88.6%), and decreased clutter to the environment (82.9%) most often (Table 1). The three most common neuroplasticity-based interventions reported included visual scanning training (82.9%), near-far focus shifts (54.3%), and visualization techniques (20.0%; Table 1).

Most Common Interventions for Visual Field Impairments

Results showed that Fresnel prisms (22.9%), base-right prisms (22.9%), and base-left prisms (22.9%) were the three most common optical devices used by the participants as therapeutic interventions. Thirteen participants (37.1%) reported that they did not use optical devices (Table 2). Scanning tasks (97.1%), head turning techniques (94.3%), and increase awareness of visual field loss (91.4%) were among the most favorable compensatory strategies reportedly used. The participants also reported that they used neuroplasticity-based interventions, such as providing verbal, auditory, and tactile cuing (88.6%), scanning worksheets (85.7%), and placing items on the side of poor vision (82.9%) to address visual field impairments.

Table 2. Interventions for Visual Field Impairments

Optical Device	No. of Responses (%)	Compensatory Strategies	No. of Responses (%)	Neuroplasticity-Based Interventions	No. of Responses (%)
Fresnel prism	8 (22.9%)	Increase awareness of visual field loss	32 (91.4%)	Establish an effective search strategy	27 (77.1%)
Base-up prism	6 (17.1%)	Dynavision	17 (48.6%)	Place items on side of poor vision	29 (82.9%)
Base-down prism	6 (17.1%)	Scanning tasks	34 (97.1%)	Provide verbal, auditory, and tactile cuing	31 (88.6%)
Base-right prism	8 (22.9%)	Head turning techniques	33 (94.3%)	Computer retraining	4 (11.4%)
Base-left prism	8 (22.9%)	Place items in field of vision	24 (68.6%)	Vision Restoration Therapy	2 (5.7%)
Press-on prism	3 (8.6%)	Anchoring techniques for reading	26 (74.3%)	Walking while scanning	28 (80.0%)
Gottlieb Visual Field Enhancement System	0 (0.0%)	Saccadic eye movement training	25 (71.4%)	Scanning worksheets	30 (85.7%)
EP Horizontal	0 (0.0%)	Add color and contrast to door frames and furniture	18 (51.4%)	Saccadic eye movement training	23 (65.7%)
Chadwick Hemianopsia System	0 (0.0%)	Education viewing	7 (20.0%)	None	0 (0.0%)
InWave Hemianopic lenses	0 (0.0%)	Additional mirrors	4 (11.4%)		
Filters or absorptive lenses	2 (5.7%)	None	0 (0.0%)		
None	13 (37.1%)				

*Note. Results were from "check all that apply" question.

Table 3. Interventions for Oculomotor Deficits

Optical Device	No. of Responses (%)	Compensatory Strategies	No. of Responses (%)	Neuroplasticity-Based Interventions	No. of Responses (%)
Fresnel prism	6 (17.1%)	Anchoring techniques	17 (48.6%)	Gaze stabilization exercises (pursuits and saccades)	24 (68.6%)
Reversing prism	1 (2.9%)	Brock posture board	2 (5.7%)	Alternating proximal and distal targets of the same and various sizes	17 (48.6%)
Press-on prism	1 (2.9%)	Red/Green reading sheets	10 (28.6%)	Alternating reading from text in distal and proximal planes	8 (22.9%)
Taping-partial occlusion	25 (71.4%)	Red/Green tranaglyphs	7 (20.0%)	Taping-total occlusion	13 (37.1%)
Patching	16 (45.7%)	Carl's cards	4 (11.4%)	Taping-partial occlusion	22 (62.9%)
Filter or absorptive lenses	3 (8.6%)	Aperture rule	1 (2.9%)	Patching	14 (40.0%)
None	5 (14.3%)	Vectogram/ Vectographs	6 (17.1%)	Active range of motion exercises	21 (60.0%)
		None	7 (20.0%)	Activities to obtain fusion	15 (42.9%)
				Computer retraining	3 (8.6%)
				Pencil push-ups	17 (48.6%)
				Brock-string exercises	20 (57.1%)
				3D fusion game	6 (17.1%)
				Word games and puzzles	23 (65.7%)
				None	2 (5.7%)

*Note. Results were from "check all that apply" question.

Most Common Interventions for Oculomotor Deficits

Participants reported to have used partial occlusion (taping; 71.4%), patching (45.7%) and Fresnel prisms (17.1%) as the most frequent optical devices used for intervention (Table 3). Compensatory strategies currently used by the participants were anchoring techniques (48.6%), red/green reading sheets (28.6%), and red/green tranaglyphs (20.0%; Table 3). The participants also reported that they used the neuroplasticity-based interventions of gaze

Table 4. Percent of Occupational Therapists Who Provide Specific Intervention Based on Visual Impairment

Type of Deficit	Optical Devices		Compensatory Strategies		Neuroplasticity-Based Intervention	
	Provide Intervention	No Intervention Provided	Provide Intervention	No Intervention Provided	Provide Intervention	No Intervention Provided
Impaired Visual Acuity	77.1%	22.9%	100.0%	0.0%	91.4%	8.6%
Visual Field Impairment	62.9%	37.1%	100.0%	0.0%	100.0%	0.0%
Oculomotor Deficit	85.7%	14.3%	80.0%	20.0%	94.3%	5.7%

stabilization exercises (pursuits and saccades; 68.6%), word games and puzzles (65.7%), and partial occlusion (taping; 62.9%) to address oculomotor deficits.

Comparison between Interventions Based on Types of Visual Impairment

The participants reported the use of compensatory strategies 100% of the time when working with individuals with impaired visual acuity and visual field deficits (Table 4). Only 80.0% of participants reported to use compensatory strategies for oculomotor deficits, while 94.3% and 85.7% reported neuroplasticity-based interventions and use of optical devices, respectively (Table 4). It was also noted that 100.0% of participants provided neuroplasticity-based interventions for visual field impairments, and only 62.9% of participants provided optical device intervention.

Discussion

The results of this study trended toward support of the hypothesis that compensatory strategies were used most often by occupational therapists to address visual impairments of individuals with TBIs. For visual acuity impairments, the participants indicated that compensatory strategies were considered a primary approach that occupational therapists use; next were optical devices and last, neuroplasticity theory-based interventions. Similarly, for visual field impairments, compensatory strategies were used more frequently than optical devices but were equally sought out as neuroplasticity-based interventions. Yet, for oculomotor deficits, the results showed that a higher percentage of occupational therapists used neuroplasticity-based interventions.

One hundred percent of occupational therapists currently implement compensatory strategies when providing vision rehabilitation to individuals with visual field impairment. This is significant due to current research revealing the effectiveness of compensatory methods as intervention for visual field loss. Specifically, a study on scanning training determined that this intervention method was effective in improving detection and reaction time during exploratory eye movements in individuals with visual field loss.[18] The training revealed improvement in functional tasks in daily living. In another study,[19] participants were trained to adapt to their visual deficits; this increased their performance in ADLs and reaction time by improving their ability to visual scan their environment. While there was no evidence to suggest that the visual field deficits improved, the individuals were able to manage the losses better.

In this present study, 80% of occupational therapists provided compensatory strategies as intervention for oculomotor deficits. Comparatively, compensatory strategies were used by 100% of occupational therapists to address impaired visual acuity. This is consistent with a study[34] which found that compensatory scanning training is effective for oculomotor deficits. When compensatory scanning training is combined with optometric correction, it is effective in treating neurological vision impairments.

The results showed that 77.1% of occupational therapists used optical devices to address impaired visual acuity. Results of research[34] suggest that the vast majority of adults with age-related macular degeneration who seek low vision services utilize prescribed optical devices and are compliant for the three months after initial prescription. Optical devices were used for the treatment of visual field impairments by 62.9% of surveyed therapists.[35] The use of peripheral prism glasses was a beneficial optical device for individuals seeking independently to navigate within their environment.[36] Optical devices were used by 85.7% of occupational therapists who treated individuals with oculomotor deficits.[35] Studies show that the clinical application of Fresnel membrane prisms were effective in treating diplopia in adult patients.[37]

Pertaining to neuroplasticity theory-based interventions, the results revealed that 91.4% of occupational therapists utilized this intervention method for visual acuity. The results also indicated that occupational therapists utilize neuroplasticity theory-based interventions 100% of the time with treating visual field impairments. There was no current research identified in the literature review regarding neuroplasticity theory-based interventions for directly treating visual acuity. Neuroplasticity, the use of compensatory scanning training combined with optometric corrections, yields improvements in visual acuity and visual field impairments.[34,38] Neuroplasticity theory-based interventions were used by 94.3% of participants to treat oculomotor deficits. Vergence-based oculomotor rehabilitation was effective in individuals with mild TBI.[39] Improvements with vergence-based motor control were attributed to neuroplasticity and oculomotor learning specific to individual condition. The findings suggested that neuroplasticity methods following TBIs may stabilize the eye, resulting in improved visual acuity. Further, existing knowledge regarding prisms, tints, and emerging vision interventions for vision dysfunction associated with the treatment of TBI suggest that visual processing occurs on a cortical level.[29]

Vision Therapy for Convergence Insufficiency (Used with Permission of WOW Vision Therapy)

Limitations and Future Research Directions

Limitations include a small sample that may not be representative of the occupational therapy practitioner population, limited to just one state, hindering generalizability. Another limitation was a low response rate. Seventy surveys were distributed among 8 sites; however, only 36 were completed, and 35 were included in data analysis. In order to gain a more representative sample of occupational therapists who provide vision rehabilitation services for individuals with TBI, it is recommended to expand the geographic region, the number of sites, and practice settings.

Because surveyed occupational therapists were recruited from eight facilities, a participant selection bias may exist, and their interventions may be based on resources available in their facilities. Years of practice may also influence the selection of interventions based on education and clinical experience. Along with expanding and randomizing the study sample, it would be beneficial to cross-reference the data based on area of practice, location, and experience that influences selection of intervention. There is a need for further research to identify intervention methods used and the effectiveness of these methods on occupation and patients' quality of life.

Conclusion

This study identifies common methods of visual intervention used by a sample of occupational therapists. Practitioners use compensatory strategies, optical devices, and neuroplasticity theory-based interventions to address visual impairments most often to impact rehabilitation outcomes for patients with TBI, ABI, and low vision. The ability to see completely and clearly affects one's capacity to participate in many ADLs, IADLs, and leisure activities safely and efficiently. Individuals who experience a TBI and secondary impairments of visual function will benefit from practitioner use of evidence-based vision rehabilitation interventions.

In summary, further interprofessional collaborative research between neuro-ophthalmologists, neuro-optometrists, and occupational therapists is needed to determine how refractive correction, prismatic correction, and graded occlusion impact the long-term effectiveness of compensatory strategies, neuroplasticity-based interventions, and other optical devices for maximum occupational performance and quality of life.

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