Vision Rehabilitation After Traumatic Brain Injury

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KEYWORDS

• Traumatic brain injury • Visual dysfunction • Vision rehabilitation • Vision therapy • Concussion

KEY POINTS

- Visual dysfunctions and symptoms are commonly experienced after even mild traumatic brain injury (TBI) despite excellent visual acuity.
- All individuals who have experienced a TBI/concussion should be screened for vision symptoms and visual dysfunction.
- A TBI-specific eye examination is necessary to identify the visual sequelae of TBI as well as address any vision/ocular issues that may be contributing to other post-TBI complaints, such as headache, photosensitivity, and vertigo.
- Recognizing and establishing your local vision rehabilitation network of professionals will offer a comprehensive approach for the patient experiencing visual dysfunction and visual deficits due to TBI.
- Combining office-based and home-based vision therapy training will maximize visual potential and functional results.

INTRODUCTION

Visual dysfunction and vision-related symptoms are common but often overlooked sequelae of traumatic brain injury (TBI). Approximately 70% of the brain is either directly involved with visual processing or is a component for other sensory processing.[1,2] Six of the 12 cranial nerves pertain to vision and visual/ocular functions. In addition, the areas of the brain that are most likely to be injured during a TBI (frontal,

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occipital, temporal, and parietal lobes, as well as the long axonal fibers connecting the midbrain to the cortex) are vision related.[1] Thus, it is not surprising that even a mild TBI/concussion can lead to significant visual sequelae that will adversely affect rehabilitation and quality of life.

Much of what we now know about how brain injury affects the visual system was gleaned from research performed within the Department of Defense (DoD) and the Department of Veterans Affairs (VA) systems. Although earlier research postulated a different mechanism of action for blast-related TBI than non–blast-related TBI, more recent research has found minimal difference in the visual sequelae between blast-related and non–blast-related TBI.[1,3,4] This suggests that VA and DoD research concerning the assessment and management of the visual sequelae of mild TBI can be applicable to those sustaining a mild TBI/concussion in the civilian setting.

VISUAL IMPAIRMENT VERSUS VISUAL DYSFUNCTION

Visual impairment or blindness occurs when visual acuity is decreased and or the visual field is constricted. The incidence of diagnosed visual impairment and blindness resulting from TBI ranges from approximately 9% to 38% depending on the definition used, the mechanism of injury (blast vs non-blast) and the severity of the TBI, with most cases occurring in blast-related moderate to severe TBI.[3,5–7]

Visual dysfunction refers to a disorder of any visual function, such as oculomotor and accommodation, visual spatial deficits, and photosensitivity. Visual dysfunctions and symptoms are commonly experienced after TBI despite excellent visual acuity.[1,2,4,5,7,8] They can contribute to headache and dizziness; cause diplopia, eye fatigue, and an inability to focus; adversely affect reading and all near tasks; and contribute to photophobia.[4,6,8–10] Undiagnosed, the visual sequela can affect school, work, and other activities of daily living.

Visual Symptoms and Dysfunction in Traumatic Brain Injury

Self-reported vision complaints, including blurry vision distance and near, eye strain, eye pain, double vision, bumping into objects, difficulty reading, and light sensitivity, range from 65% to 79% depending on the study design and patient population.[1,3,4,6,8–10] Difficulty reading was a common complaint (32%–66%),[1] as was light sensitivity (33%–69%).[1,4,8–10]

The visual dysfunctions most often identified were convergence insufficiency, accommodative dysfunction, and photosensitivity.[3,4,6,7,9–11]

Other visual anomalies, such as visual field loss, cranial nerve disorder, strabismus, pursuit/saccade disorder, diplopia, and ocular injuries, are less frequently diagnosed and are more often found in moderate to severe TBI. The wide range in the frequency of visual dysfunction in people with TBI is most likely due to differences in settings and patient populations. Studies reporting data on unscreened individuals with TBI report much lower rates of visual dysfunction than studies that use self-report measures to screen for visual symptoms, highlighting the value of screening for visual dysfunction in patients with TBI.

MILD TRAUMATIC BRAIN INJURY

Screening for Visual Dysfunction in Mild Traumatic Brain Injury

Not all rehabilitation settings will have optometrists/ophthalmologists on staff to provide an eye examination for persons who have experienced a mild TBI. In such cases, a method to screen patients with TBI for possible visual symptoms should be implemented.

Brain injury vision symptom survey questionnaire

The Brain Injury Vision Symptom Survey (BIVSS) Questionnaire is a 28-item self-administered survey for vision symptoms related to TBI.[12] It probes multiple dimensions of vision-related behaviors, including eyesight clarity, visual comfort, diplopia, depth perception, dry eye, peripheral vision, light sensitivity, and reading and is the screening tool of choice for visual symptoms related to mild TBI.

Screening protocol for therapists

Although symptom surveys are quite useful in identifying individuals who have visual symptoms, a more in-depth screening protocol is necessary to determine if the visual symptoms are such that an additional evaluation by an optometrist or ophthalmologist is required. Occupational therapists, vision rehabilitation therapists, and blind rehabilitation outpatient specialists within the VA system can perform additional screening tests to facilitate the appropriate referrals. A consensus panel of occupational therapists and optometrists suggested a screening protocol designed to identify TBI-related vision disorders in adults.[13] **Table 1** uses their recommendations with a few updated modifications.

In addition, although the consensus of this group did not include computerized vision screening programs, such as the Home Therapy System (HTS) Binocular Vision Assessment (HTS Inc, Gold Canyon, AZ) and VERA vision screening software (Visual Technology Applications, Philadelphia, PA), the computerized vision screening programs do show promise, and in one small study showed excellent validity and repeatability for assessing near-related binocular vision problems and pursuit and saccadic eye movements.[14,15] HTS Vision Therapy is a computer program that can be used as an in-office screening tool for accommodation, vergence, and eye movements (pursuits and saccades). It also contains the Computerized Perceptual Therapy System, which evaluates visual perceptual areas including visual concentration, visual closure, visual processing, and visual sequential memory.

The Traumatic Brain Injury–Specific Vision Evaluation

A TBI-specific vision evaluation is indicated when a patient has experienced a TBI. Before the TBI vision evaluation, a comprehensive baseline refractive and ocular health examination is important to address non–TBI-related vision issues. It is

Table 1
Screening tests for visual sequelae in mild traumatic brain injury

Test with corrective lenses if appropriate: older than 40, may need reading glasses	
Symptom self-report	Brain Injury Vision Symptom Survey
Distance visual acuity	Distance Snellen chart
Near visual acuity chart	Any near single letter/number chart
Accommodation	Accommodative amplitude test
Convergence	Near point of convergence
Eye alignment and binocular vision	Stereo test
Saccades	Developmental eye movement test
Pursuits	Northeastern State University College optometry oculomotor test
Visual Fields	Confrontation visual fields finger Counting

Courtesy of Sandra Fox, OD, San Antonio TX, USA.

common to have refractive error, such as latent hyperopia that is often symptomatic after the TBI. A thorough damp refraction with dilation is helpful to detect latent hyperopia, which will cause near or accommodative vision challenges. Ruling out any preexisting ocular disease is important. Patients with TBI often have dry eye syndrome that adds to fluctuations in vision. It is recommended that patients with TBI have a baseline screening visual field test.

In addition to visual sequelae such as oculomotor dysfunction and photosensitivity, common complaints after mild TBI include headaches, vertigo, and difficulty reading and concentrating while reading. The role of the optometrist/ophthalmologist is to address any vision/ocular issues that may be contributing to these complaints.

Box 1 from the Walter Reed National Military Medical Center Vision Center of Excellence includes the eye/vision tests that are included as the basic components of an eye examination.

Patient History

Considering what we now know about mild TBI/concussion, a question pertaining to military service and a history of high-impact sports should be a part of every medical/social history. Any positive responses should prompt additional TBI-related questions designed to determine if there is a possible oculomotor dysfunction. See **Box 2** for additional TBI-related questions.

Additional Testing

Oculomotor dysfunction

If a patient is symptomatic for oculomotor dysfunction, additional clinical testing must be performed to evaluate visual efficiency to determine the specific types and

Box 1
Basic eye care/vision examination by an eye care provider

History[a]

Visual acuity

Refractive error measurement

External examination

Pupillary testing

Extraocular muscle testing/pursuits

Cover test (distance and near)

Confrontation visual field testing

Tonometry

Slit lamp biomicroscopy: anterior segment, cornea, macula, lens, and optic nerve

Binocular indirect ophthalmoscopy with scleral depression[b]

Gonioscopy[b]

[a] It is recommended that assessment of medical history also include the question, "Have you been exposed to blast or sustained a head injury, concussion, or traumatic brain injury (TBI)?" A positive response to this question would be a sufficient rationale to ask TBI-related ocular history questions and conduct supplemental testing.

[b] If patient history indicates exposure to blast, head injury, concussion, and/or TBI.

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Box 2
TBI-related ocular history questions

Did you have any neurologic problems or symptoms before your TBI (multiple sclerosis, stroke, brain tumor, severe headaches, other)?

When did your TBI occur (on what date)?

Did you lose consciousness during or after your TBI incident?

Were you disoriented or confused during or after your TBI incident?

Do you bump into objects and walls more now than before your injury?

Were your eyes, eyelids, or area around your eyes injured when your TBI event occurred?

Do you cover or close one eye at times since your injury?

Have you noticed a change in your vision since your injury?

Are you more sensitive to light, either indoors or outdoors, since your injury?

Have you had any double vision since your injury?

Have you noticed any changes in your peripheral vision since your injury?

Is your vision blurry at distance or near since your injury?

Have you noticed a change in your ability to read since your injury?

Do you lose your place while reading more now than before your injury?

How long can you read continuously before you need to stop?

Do you get headaches during/after reading more now than before your injury?

Do you have more difficulty remembering what you have read now than before your injury?

Data from Goodrich G, Martinsen G. Development of a mild traumatic brain injury-specific vision screening protocol: a Delphi study. J Rehabil Res Dev 2013;50(6):757–68; and Previously published materials from Walter Reed National Military Medical Center/Vision Center of Excellence. 2016; with permission.

severities of oculomotor dysfunction. **Table 2** lists the oculomotor dysfunction parameters that need to be tested and methods that can be used.

Visual information processing

Visual information processing, which includes visual spatial information, visual analysis, and visual motor integration, also needs to be evaluated. **Table 3** pertains to visual information processing function, description, and testing methods.

Simple observation of the patient's gait and balance can diagnose spatial localization problems. This may or may not be present with motion sensitivity, which is common in crowded places. Patients may report feeling dizziness, nausea, and unsteadiness.

Treatment Strategies

Once the visual dysfunction has been identified, a treatment plan will need to be developed to improve the visual efficiency. **Box 3** describes the treatment strategies used for oculomotor dysfunction.

Rehabilitation Team

As with any rehabilitation plan, it is often necessary to have coordination of subsequent referrals to other services. The goal is to understand how various vision

Table 2
Recommended tests to evaluate for oculomotor dysfunctions

Oculomotor Parameter	Testing
Eye alignment	*Distance and near cover test in multiple positions of gaze and head tilt* *Phorias (vertical and horizontal)* Maddox rod Modified Thorington
Vergence	*Vergence ranges (vertical and horizontal)* *Vergence facility*
Convergence amplitude	*Near point of convergence* Repeated measures
Accommodation	*Push-up method* Repeated measures *Minus lens* Repeated measures *Accommodative facility (monocular and binocular)* *Negative relative accommodation/Positive relative accommodation (NRA/PRA)* Near retinoscopy Accommodative convergence/accommodation (AC/A) ratio
Eye movements	*Ductions* *Versions* *Pursuit* *Saccades* Developmental eye movement (DEM) King-Devick
Suppression check	*Worth 4 Dot (distance and near)* Random dot stereopsis
Vestibulo-ocular reflex	(If positive, refer to audiology, otolaryngology, or vestibular physical therapist) Dynamic visual acuity Head thrust Low-frequency head shake

Note: not all tests are required; italicized tests provide more comprehensive results as recognized by our expert panel, but selection of tests is left to the clinical judgment of the eye care provider.
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problems affect function. See **Table 4** for additional specialties that may need to be consulted.

Plan of Care of Oculomotor Dysfunctions Associated with Traumatic Brain Injury

Fig. 1 is an algorithm outlining the process for the care of the patient with oculomotor dysfunctions associated with TBI.

Vision Rehabilitation for Mild Traumatic Brain Injury

Vision rehabilitation after mild TBI can be further complicated by comorbidities and must be considered when developing the rehabilitative plan.

Comorbidities

In the military/veteran TBI population, there is a high prevalence of comorbid drug/substance abuse and mental illness, further complicating the diagnosis and treatment of visual symptoms. Among veterans with TBI, 89% had a comorbid psychiatric

Table 3
Recommended tests to evaluate visual information processing

Function	Description	Tests
Visual spatial	Ability to tell where objects are in space and in relation to yourself	Draw a clock from memory Line bisection (2 levels) Copy picture (2 levels) Letter cancellation
Visual analysis	Ability to determine awareness of size and color	Test of Visual Perceptual Skills: form constancy, visual closure, visual memory
Visual motor integration	Hand-eye coordination Ability to control hand movement guided by vision	Writing skills Pen and paper tests Tangrams Parquetry block designs
Spatial localization	The reference of a visual sensation to a definite locality in space	Dynavision Walking obstacle course Walking gait testing Balance testing (TUG, POMA)

Abbreviations: POMA, tinetti performance oriented mobility assessment; TUG, timed up and go.

diagnosis, most commonly with posttraumatic stress disorder (PTSD),[16] in which the prevalence has been found to be as high as 89%.[17]

Posttraumatic stress disorder

PTSD is associated more often with mild TBI than in more severe TBI[18,19] and can complicate the clinical presentation. A study comparing the *visual function* of veterans with TBI only with that of veterans with TBI and PTSD found high rates of oculomotor dysfunction in both groups with no difference between patients with or without PTSD, indicating that the oculomotor dysfunction is a sequela of the TBI.[18] Those with comorbid PTSD did have more self-reported visual symptoms and higher complaints of photosensitivity and there is some thought that hypersensitivity could play a role in the increased reporting of visual symptoms.[20]

Posttraumatic headaches

Headache is one of the most common and persistent symptoms after TBI and is more likely to persist after mild TBI than moderate or severe TBI. The chronic symptomatology of service members and veterans following TBI is an overlap of chronic posttraumatic headaches, PTSD, and other psychiatric disorders.[21]

Vertigo

A TBI can disrupt the coordination of sensory input from the visual, vestibular, and somatosensory pathways necessary for balance and stabilization in the visual environment. Dizziness and vertigo are common complaints after a TBI.

Photosensitivity

Photosensitivity is more common in mild blast-related TBI. Approximately 50% will experience a decrease in photosensitivity over time and those who do not wear darkly tinted lenses are more likely to notice a decrease in sensitivity over time. The factors that were associated with hindering or inhibiting photosensitivity reductions included dry eye, migraines, hyperacusis, and loss of consciousness,[22] all common conditions in the military/veteran population. In addition, veterans with PTSD and mild TBI endorse photosensitivity much more frequently than those without PTSD.

Box 3
Treatment strategies for oculomotor dysfunction

Correction of refractive error to improve vision, binocular alignment, and accommodative function

Added lenses to improve binocular alignment and accommodative function

When necessary, prism therapy to eliminate double vision and restore visual comfort

Office-based oculomotor rehabilitation (with home-reinforcement) using a variety of procedures to improve oculomotor function

When necessary, surgery for associated strabismus or other relevant oculomotor problems

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Before vision rehabilitation, it is important to rule out any visual or ocular conditions that may be contributing to headaches, vertigo, and photosensitivity, as well as whether PTSD may be contributing to the symptomatology.

Vision Rehabilitation Team

The ideal setting for providing the patient with TBI with appropriate vision care and vision therapy is a team of providers working together in a vision clinic.[23] Because most rehabilitation services for the population with mild TBI occur in an outpatient setting, it is vital to establish a professional support network that evaluates and treats vision-related issues.

Vision rehabilitation specialists may include occupational therapists, certified low-vision therapists, optometrists, and typically other trained blind rehabilitation specialists with knowledge in vision therapy training. It is imperative that the vision therapists work closely with the eye care practitioner's plan of care and provide regular updates as to the patient's therapy progression, regression, and/or plateau of skills, as this may require reevaluation of the vision therapy treatment plan.

Types of Vision Rehabilitation Programs

Vision rehabilitation settings in mild TBI may include an optometrist/ophthalmologist office or facilities with inpatient and/or outpatient rehabilitation clinics. Within Veterans Affairs Medical Centers, inpatient and outpatient clinics exist that offer specialty rehabilitation programs aimed at evaluating and training those with visual dysfunctions resulting from TBI.

Table 4
Referral to appropriate facility-specific provider

Audiology/Otolaryngology/Vestibular Physical Therapy	Speech/Language Therapy
Blind/Low-Vision Rehabilitation	Neurology/Neuro-Ophthalmic Care
Occupational Therapy	Psychology/Psychiatry/Neuro-Psychiatry
Physical Therapy	

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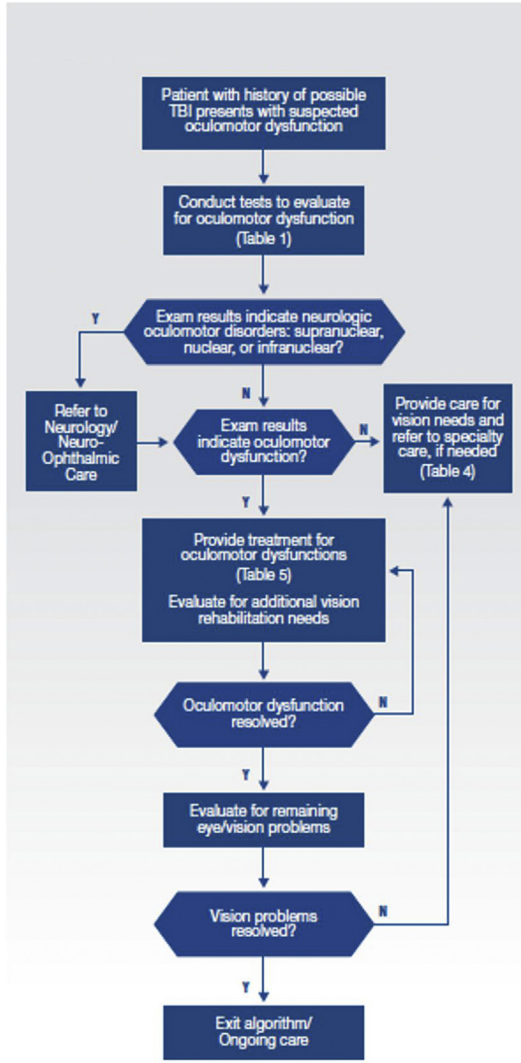

Fig. 1. Algorithm for the care of oculomotor dysfunctions associated with TBI. (*From* Walter Reed National Military Medical Center/Vision Center of Excellence. 2016; with permission.)

Vision Therapy

The American Optometric Association defines vision therapy as a sequence of neurosensory and neuromuscular activities individually prescribed and monitored by the doctor to develop, rehabilitate, and enhance visual skills and processing.[24] The goal of vision therapy is to improve the speed, accuracy, and integration of oculomotor functions.

Eye movements include motions that shift the direction of eye gaze, such as saccades, pursuits, and vergences.[25] Oculomotor dysfunctions associated with TBI may affect many areas of daily living, including reading, visual learning, and ability to concentrate. Vision therapy is an accepted treatment of choice for the most

common TBI-related visual dysfunctions. See Table 5 for management and treatment options for common oculomotor dysfunctions associated with TBI.

Office-based and home-based vision therapy treatment strategies

Once a vision therapy plan of care is developed, the patient (and family) should be educated about the relationship between the visual deficit and dysfunction and the ability to complete a visual task. A schedule should be created for regular inpatient training (office visit) with a home exercise program (HEP) for therapy reinforcement. The HTS program can be provided to the patient as an excellent home therapy tool for those individuals with access to computers. Complying with the HEP is crucial for success.

Duration of vision therapy and frequency

A patient's motivation and commitment are key to success for any vision therapy training program. The average duration for most vision therapy programs range

Table 5
Management and treatment options for common oculomotor dysfunctions associated with traumatic brain injury

Condition	Primary Treatment	Secondary Treatment
Accommodative insufficiency Ill-sustained accommodation	Plus-powered lenses	Oculomotor rehabilitation
Accommodative excess	Oculomotor rehabilitation	
Convergence Insufficiency	Oculomotor rehabilitation	Prism lenses Extraocular muscle surgery
Convergence excess	Plus-powered lenses	Oculomotor rehabilitation
Fusional vergence dysfunction	Oculomotor rehabilitation	
Divergence insufficiency	Prism lenses	Oculomotor rehabilitation
Divergence excess/basic exophoria	Oculomotor rehabilitation	Extraocular muscle surgery
Basic esophoria	Prism lenses	Oculomotor rehabilitation
Vertical phoria	Oculomotor rehabilitation and prism lenses	Extraocular muscle surgery
Saccadic dysfunction	Oculomotor rehabilitation	
Cranial nerve (CN) III palsy	Fresnel prism, ptosis crutch, near lenses	Extraocular muscle surgery
CN IV palsy	Fresnel prism, distance and near glasses, base down near yoked prism, reading stands, sector occlusion, and/or full field occlusion Prisms likely ineffective if significant torsion	Oculomotor rehabilitation Extraocular muscle surgery
CN VI palsy	Fresnel prism	Oculomotor rehabilitation Medications Extraocular muscle surgery

Adapted from Scheiman M. Understanding and managing vision disorders after traumatic brain injury. A guide for military optometrists. Washington, DC; Office of the Surgeon General: 2011; and Previously published materials from Walter Reed National Military Medical Center/Vision Center of Excellence. 2016; with permission.

between 4 and 6 weeks, depending on the patient's goals. It is recommended that patients attend weekly in-office therapy in addition to home vision therapy to make certain they are accurately performing the therapy.

Office-based vision therapy training should resemble a "fitness center" for the eyes, using a multitude of devices or techniques aimed at isolating and improving the specific visual function.

Tint Evaluation

Based on the patient's self-report or symptom checklist, the vision therapist should evaluate each type of glare experienced by the patient, including outdoor, indoor, computer screen/iPhone, and night glare. Distant acuity charts may prove beneficial to evaluate visual clarity during indoor and outdoor tint evaluations. For those patients using darker tints, the goal is to decrease the tint level over time (increase light transmission levels) and improve their tolerance of brighter environments. Exceptions would be patients who experience migraines and patients who have abnormally large pupil size (often secondary to medication). *PTSD as a comorbidity can complicate the tint assessment and the goal of decreasing tint over time.*

MODERATE TO SEVERE TRAUMATIC BRAIN INJURY

Individuals who experience a moderate or severe TBI will have visual sequelae like those with mild TBI; however, in addition to oculomotor/accommodative dysfunction and photosensitivity, they are more likely to experience ocular trauma whereby visual impairment is more common. Also, the more severely the brain has been damaged, the more likely a visual field deficit will be present. The frequency of ocular injuries in moderate to severe TBI ranges from 30% to 38% and includes orbital fractures, lid lacerations, traumatic cataracts, traumatic maculopathy, retinal hemorrhages, optic neuropathy, globe ruptures, angle recession, hyphema, and corneal injuries.[4,6] Blindness or legal blindness in moderate to severe TBI was found in 13% to 14%[3,6] and 18% to 32% were found to have visual field deficits.[3,4]

The Traumatic Brain Injury–Specific Eye Examination in Moderate to Severe Traumatic Brain Injury

The level of cognition may make a subjective evaluation challenging so the eye care provider may need to rely on objective findings only. The initial evaluation is likely to take place at bedside and the goal of this evaluation is to evaluate ocular health because the patient with moderate/severe TBI is more likely to have ocular trauma. More severe patients may be nonverbal or in a low level of consciousness. Assessing visual potential is crucial because visual tracking is a part of the Coma Recovery Scale and visual impairment/blindness is more likely in the patient with more severe TBI. One study found that 65% of patients with disorder of consciousness misdiagnosed as being in a vegetative state were blind or vision impaired.[26]

The visual potential is assessed by examining the ocular health, determining the refractive error, and using objective methods of assessing visual acuity, such as the optokinetic drum and preferential looking (Teller Cards).

Vision Rehabilitation in Moderate to Severe Traumatic Brain Injury

Addressing the ocular health concerns and ensuring that any refractive error is corrected is primary in the acute setting. Frequent follow-up is indicated as the patient

progresses and more subjective testing can be performed. Diplopia, visual impairment/blindness, and visual field deficits may become more apparent as the patient's cognition improves.

Cotreatment among therapists often may prove beneficial due to incorporation of multiple rehabilitation techniques that maximize training efforts and keep goals relevant to daily activities.

Examples:

- Occupational therapist reviews patient's daily task calendar, and vision therapist reinforces eye movement pursuit and fixation
- Vision therapist practices patient's visual scanning techniques on white board to locate letter, whereas speech and language pathologist practices pronunciation of letter/word
- Physical therapy provides training to patient for improved walking posture/gait and walking endurance, whereas vision therapist incorporates bilateral scanning to locate wall targets

Diplopia

Cranial nerve palsies are common after moderate to severe TBI and the resultant diplopia will adversely affect rehabilitation. Patching is not ideal, especially for mobility. Using a Fresnel press-on prism to eliminate the diplopia is preferable because the press-on prism eliminates the diplopia without significantly compromising vision. The prism power can be changed as the palsy improves over time.

Visual impairment/blindness

Determining if the patient has suffered vision loss is critical to the rehabilitation process. Once it has been determined that a patient is visually impaired, low-vision eye care providers and therapists with experience in low-vision rehabilitation will need to be consulted to partner with the patient's TBI rehabilitation team. The rehabilitation team should provide modifications and compensatory strategies that will be used for rehabilitation purposes.

The VA provides blind and vision rehabilitation programs to eligible veterans and active duty service members who are visually impaired. These training programs offer veterans the opportunity to acquire the skills necessary to regain independence and successfully integrate into their family and community life. For more information on blind rehabilitation services within the VA see http://www.prosthetics.va.gov/blindrehab/BRS_Coordinated_Care.asp.

Visual field loss

Visual field deficits have been found in 35% of patients with TBI in a sample clinic population having a range of visual symptoms.[27] Deficits of all types may be present, ranging from hemianopia to small, scattered regions of reduced sensitivity (**Table 6**).[27]

Fig. 2 is an algorithm that outlines the steps and clinical decision points in the eye care and rehabilitation process for patients with visual field loss associated with TBI/acquired brain injury.

Testing for visual field loss

Box 4 outlines the screening tests recommended to evaluate the type of vision problem the patient may be experiencing. These tests will indicate whether the visual disturbance is related to possible visual field loss.

Table 6
Types of visual field loss

The following types of visual field loss and their extent can be measured using visual field testing (perimetry):

Hemianopia/ Quadrantanopia	Characterized by the complete loss of the left or right half of the field of vision, or a smaller segment due to injury within the visual projections of one hemisphere and that may impact patient mobility
Central scotoma	Characterized by a centrally located area or areas of vision loss that reduce visual acuity
Peripheral scotoma	Characterized by focal loss of portions of the peripheral field of vision, including hemianopia, quadrantanopia, ring scotoma, and arcuate field defects that may impact patient mobility
Monocular vision	Characterized by the total loss of vision in one eye

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If initial screening testing indicates that there may be visual field loss, more extensive visual field testing should be performed. **Box 5** lists the accepted methods for visual field testing (perimetry).

Additional tests

In addition to visual field deficits, patients with TBI may experience visual neglect and other visual processing deficits that will affect activities of daily living. To evaluate for the presence of neglect as well as assess the impact of the visual field deficit on function, additional testing procedures can be used. See **Table 7**.

Rehabilitation for Visual Field Loss

Vision rehabilitation for the patient with visual field loss requires a team approach. The specific provider(s) recommended for the patient will depend on the clinical management and rehabilitation required. **Box 6** also lists providers to whom the patient may be referred if the clinical condition(s) require additional specialized management.

Visual field loss may cause one to miss words along one side of a sentence (static), or to bump into objects on the side of the visual deficit while ambulating in a hallway (dynamic). Rehabilitation techniques for visual field loss can be categorized as either “optical management” (eg, prisms, magnifiers, telescopes, reverse telescopes) or “compensatory strategies” (eg, scanning, head movement, eye movement, awareness, mobility training). Compensatory strategies are often effective because these procedures help the individual to learn to better use their remaining vision to overcome their visual field loss. Training the patient to conduct systematic visual scanning techniques and fuller head movements can improve object detection in the missing visual field and enable the individual to learn to better use their remaining vision in static and dynamic environments. **Table 8** outlines the specific rehabilitation techniques and strategies recommended for each type of visual field loss.

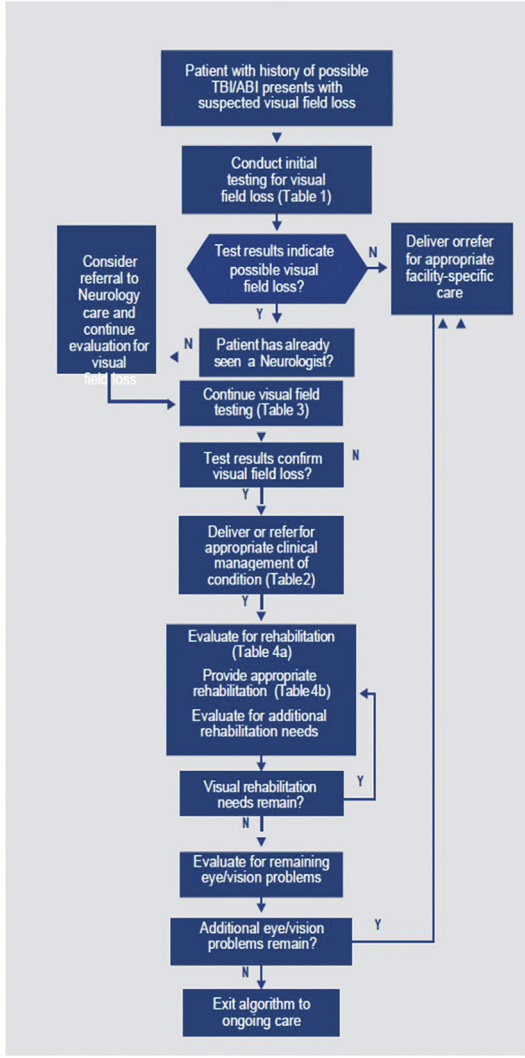

Fig. 2. Algorithm for rehabilitation process for visual field loss. ABI, acquired brain injury. (*From* Walter Reed National Military Medical Center/Vision Center of Excellence. 2016; with permission.)

Box 4
Initial screening tests for visual field loss

Confrontation field testing (nonseeing to seeing)[a]

Central visual acuity measurement

Amsler grid/facial recognition testing

Tangent screen

[a] If not already completed as part of basic eye/vision examination.
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Box 5
Visual field testing (perimetry)

Humphrey/Humphrey Esterman

Octopus

Goldmann

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REHABILITATION OVERVIEW

Visual dysfunction is commonly associated with TBI and often identified through visual symptom questionnaires, such as the BIVSS. Recognizing the visual symptomology requiring a TBI-specific eye examination is a crucial starting point toward successful patient rehabilitation. Assessments must address a patient's strengths, limitations, needs, preferences, and desired outcomes. Identifying and developing your rehabilitative referral network is vital when dealing with a TBI patient population experiencing deficits in visual function. Therapists or other rehabilitation clinicians may be the first to

Table 7
Functional visual impact tests/procedures

Functional Task	Visual Impact Test
Scanning	• biVABA (portion) • DEM (adult) • King-Devick
Visual attention	• biVABA • Rivermead (will rule out presence or absence of neglect) • Dynavision • Wayne fixation • Useful field of view
Reading/Near vision	• biVABA • Smith-Kettlewell reading test (SK Read) • Pepper test • Minnesota low-vision reading test (MN Read) • Visagraph
Visual perception	• Motor-free visual perception test (vertical is recommended but not always available) • Test of Visual Perceptual Skills (TVPS) • DVPT-Adult • Home Therapy System CPT Program
Functional independence	• Functional Independence Measure (FIM)
Quality of life (QOL)	• National Eye Institute Visual Functioning Questionnaire (NEI-VFQ-25) with 10-item euro-ophthalmic supplement • College of Optometrists in Vision Development (COVD) Quality of Life Assessment

Abbreviations: biVABA, brain injury visual assessment battery for adults; CPT, computer perceptual therapy; DEM, developmental eye movement; DVPT, developmental visual perception test.

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Box 6
Providers for clinical management and rehabilitation of visual field loss and related conditions

Optometrist/Ophthalmologist

Neurologist/Neuro-Ophthalmologist

Occupational/Physical therapist

Audiologist[a]

Low-Vision or Blind Rehabilitation Specialist (Veterans Affairs facilities)

Certified Driver Evaluation Specialist

[a] Hearing loss may compound spatial awareness difficulties caused by visual field loss.
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notice a problem, therefore, 2-way communication (between medical and rehabilitation teams) is vital.

Once an eye care provider identifies the visual deficits and/or dysfunction, a vision rehabilitation plan of care should be offered to improve visual functioning and quality of life. Successful vision rehabilitation training begins with education of the visual dysfunction to both the patient and family members. A combination of office and home therapy will offer a comprehensive approach to improving function. Vision therapy training may appear repetitive to the patient; therefore, it is important to provide multiple therapeutic activities to keep the patient engaged in therapy and minimize missed appointments.

It is equally important for the rehabilitative team to continually update the eye care practitioner regarding the patient's progress, as the plan of care may need to be altered (ie, therapist informs that patient does not wear the prism

Table 8
Rehabilitation of visual field loss

Rehabilitation	Hemianopia/ Quadrantanopia	Central Scotoma	Peripheral Scotoma	Monocular Vision
Awareness/Sensory integration	x	x	x	x
Environment training	x	x	x	x
Scanning	x	x	x	x
Reading strategies	x	x	—	—
Compensatory aids	x	x	x	—
Prisms	x	—	—	—
Near optical aids (magnifiers)	—	x	—	—
Telescopes	—	x	—	—
Reverse telescopes	—	—	x	—
Eccentric viewing	x	x	—	—
Mobility training	x	x	x	x
Fitness to drive	x	x	x	x

x, appropriate rehabilitation strategy; —, not appropriate.
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lenses). Finally, goals should be realistic and aligned with the patient's everyday tasks.

SUMMARY

The goal of *all* rehabilitation is to improve function and retain independence, thereby improving quality of life. Vision is a major component in every aspect of rehabilitation. Speech language pathologists and neuropsychologists administer cognitive tests that require reading. Physical therapists are working to improve mobility and balance, which are affected by vision. Occupational therapists are evaluating the ability to perform activities of daily living, and recreation therapists use games and crafts as part of therapy, all highly dependent on vision.

Knowledge of the patient's visual acuity, visual fields, and oculomotor function is crucial information for the rehabilitation team to accurately assess mobility and balance or the higher-level visual skills, such as visual tracking and scanning, visual memory, and visual cognition. Unfortunately, this information is often not available, and the patient's rehabilitation success can be significantly hampered.

The optometrist's role is to provide the rehabilitation team with this valuable information. Knowing your eye care provider and rehabilitation network will provide a team approach to identifying and improving potential visual dysfunctions caused by TBI.

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