Conceptual Model of Optometric Vision Care in Mild Traumatic Brain Injury

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Abstract

Optometrists are being asked to provide vision care to increasing numbers of individuals with mild traumatic brain injury (mTBI). However, the complexity of both the vision-based, and non-vision-based symptoms and related problems, as well as the multiple levels of concurrent care provided by other health-related professionals, may make the task appear daunting. We propose a four-tiered, conceptual model of optometric care in these patients that should render the task more easily achievable.

The four-tiered model includes the basic optometric examination, and analysis of ocular motor problems, non-ocular motor problems, and non-vision-based problems.

Key Words

acquired brain injury, neurological disorder, neuro-optometric rehabilitation, optometry, traumatic brain injury, vision rehabilitation, vision therapy

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INTRODUCTION

Traumatic brain injury (TBI) represents a public health care priority in the United States and in optometry for at least two major reasons. First, there are thousands of returning war fighters coming from Iraq and Afghanistan presenting with various degrees and etiologies of TBI. Many of these have residual visual problems that can be diagnosed and remediated.[1] Second, there is considerable concern and pressure from sports teams, sports medicine groups, and parents to understand and limit the frequency and intensity of sports-related head injuries. It is estimated that as many as 10% of all athletes have sustained one or more head injuries.[2]

Many of these individuals with TBI, in particular mild traumatic brain injury (mTBI), will be examined in a Veteran's Administration (VA) hospital (a veteran) or by a local optometrist if they are a civilian. The need for appropriate vision care will likely accelerate over the foreseeable future due to this growing population, heightened private/public awareness, and improved brain imaging technology. There has been, however, a lag in the formal educational process in this area for all vision care professionals. In addition, there is the perception by these professionals that mTBI patients are very complicated to manage.

The multitude of visual conditions and other co-morbid medical conditions complicate a diagnosis of mTBI. The starting point and roadmap to completion of the optometric vision examination, and later the diagnoses/therapeutic plans, may lose focus and structure in these cases.[3] For example, consider the following scenario: JK is a 25-year-old male who sustained an injury to the frontal area nine months ago in a motor vehicle accident. His present complaints are: intermittent blur at distance and near, intermittent vertical diplopia at distance, and headaches following short periods of reading. He also has related concentration problems, visual fatigue, dry eye, a retinal tear in the right eye, cognitive impairment, and depression. He is taking medications for the depression, dry eye, and headaches. He also takes several vitamins and nutritional supplements. JK has weekly appointments with an occupational therapist to improve his executive function ability, a psychologist to improve his cognitive ability, and a psychiatrist to reduce his depression. Presentation of such a patient may initially seem to be overwhelming to the optometrist.

With the above in mind, we have developed a four-tiered, conceptual model of optometric vision care for individuals with TBI, in particular those 70-80% having mTBI.[1,2,4] It may also apply, with some modifications, to those with other types of acquired brain injuries (ABI). We believe that with such a conceptual model guiding the optometric vision examination, the task will no longer appear to be so daunting. Hopefully, this model will provide a more structured approach to those already providing vision care to TBI patients, and a starting point for those who are not yet so engaged.

Four-Tiered Conceptual Model

Our conceptual model is presented in Table 1. Each of the four tiers, or components, will be briefly addressed. It is assumed that the reader is familiar with all of the basic concepts and suggested forms of care and/or remediation. Selected references will be provided to the reader for additional information.

Tier 1: The Basic Optometric Vision Examination

There are three aspects to the basic optometric vision examination. These include assessment of refractive status, binocular status, and ocular health status. Thus, it is assumed that before proceeding to tiers 2, 3, and 4, the patient has been refracted carefully at both distance and near, basic binocular testing has been completed (e.g., phoria, vergence ranges, relative accommodation), and any ocular/medical health issues are either being treated or appropriately referred.

Tier 2: Oculomotor-Based Vision Problems

This tier involves a more comprehensive investigation and testing related to the specific oculomotor-based vision problems commonly found in the mTBI population. This leads to the final diagnoses, followed by therapeutic interventions, for any version, vergence, and/or accommodative deficits.[5,6]

Assessment of versional eye movements includes the fixation, saccade, pursuit, vestibular, and optokinetic systems. These tests should be performed under monocular and binocular viewing conditions at far, intermediate, and near distances in all directions of gaze. Any gaze limitations (e.g., paresis) should be noted. Symptoms may include loss of place while reading and visual scanning problems. Remediation of any deficits would include optometric vision therapy, or in the case of a head turn in those patients with nystagmus, yoked prisms (e.g., 5-10pd) should be incorporated into the spectacle correction to reduce the head turn and minimize any related neck discomfort.

Assessment of vergence eye movements includes: accommodative vergence and the AC/A ratio, fusional vergence ranges at distance and near, phorias at distance and near, vergence flexibility at near, and the near point of convergence. Symptoms may include intermittent diplopia at near and visual fatigue. Remediation of any deficits would include vision therapy, near vergence/accommodative interactive "balance" lenses[5,7] (e.g., +1.00 or +1.25D), and/or prisms (e.g., 4pd total base-in for the commonly found convergence insufficiency in this population).[5,6]

Assessment of accommodation includes the amplitude of accommodation, lag of accommodation, relative accommodation, and accommodative flexibility at near. Symptoms may include intermittent blur at near and visual fatigue while reading. Remediation of any deficits would include vision therapy and/or near lenses as described earlier for vergence.

Tier 3: Non-Oculomotor-Based Vision Problems

There are several different and diverse aspects to be considered regarding the multitude of non-oculomotor-based vision problems found in this population.[4,6,8] Each will be briefly discussed. Any one or a combination of these problems can confound, and thus make more difficult, both the basic and more specialized vision examination procedures as described in tiers 1 and 2.

A shift in one's spatial "sense of straight ahead," that is "abnormal egocentric localization" (AEL), is frequently found in the TBI population, and elsewhere in stroke with hemianopia and visual neglect. Symptoms may include difficulty with ambulation and mislocalization of objects. Yoked prisms (i.e., prisms with bases in the same direction) can be applied horizontally (typically), vertically, or obliquely, using a variety of simple techniques.[9] The prism magnitude is slowly increased until the mismatch between the patient's objective (i.e., veridical) and anomalous subjective directional sense is either reduced or nulled. Furthermore, with the prisms, their overall sense of visual space and ambulation should be improved (e.g., they now feel "in synch" with their environment when ambulating). Typical values horizontally are between 2-6 pd at distance, and perhaps a few prism diopters more at near when reading. In contrast, prism magnitudes are typically no more than 1-2 pd vertically when needed.

Photosensitivity is a common problem. These patients are particularly sensitive to fluorescent lighting and its related "flicker." Tints of 20-30% can be incorporated into the spectacle correction for outdoor and/or indoor viewing (e.g., BPI Omega or Anifra bluish tint). In addition, a wide-brimmed hat may be beneficial to occlude the overhead illumination.[6]

Another common symptom is motion sensitivity. These patients are troubled by dynamic, moving environments such as found in a crowded supermarket. They may feel unsteady and even nauseous at times. The use of binasal occluders is frequently of considerable benefit. It is best if they incorporate black tape, although they may also be useful when constructed from multiple layers of translucent tape. Form perception must be eliminated to be effective, presumably by reducing some of the peripheral visual motion. Sometimes a tint may also be helpful, as it reduces the luminous intensity of the moving retinal imagery. Lastly, motion desensitization techniques can be employed to habituate the patient to the undesirable motion[5]. This can be accomplished with hand motion in the far peripheral visual field and/or peripheral optokinetic stimulation producing Gibsonian optic flow on the retina.[5,10]

Vestibular problems occur in many of these patients as well. Symptoms may include dizziness, blurred vision, and nausea. Vestibular/vergence interactive techniques can be employed by the optometrist to improve overall oculomotor responsivity. For example, one can train the horizontal and vertical vestibulo-ocular reflex by using head rotation techniques over a range of distances and gaze angles under monocular and binocular viewing conditions.[5,6] The patient may also be referred to a vestibular rehabilitation center.

Visual field defects are found in some patients. Symptoms may include bumping into objects and difficulty with ambulation. One can use visual scanning techniques into the defective field to improve object identification and ease of ambulation. In addition, sector prisms can be incorporated into the spectacle lenses to function as a "spotting" system when needed to investigate for the presence of objects (e.g., people and cars) in the missing region of the visual field.[5,6]

Lastly, a range of visual information processing and perceptual deficits are frequently found in this population. Symptoms may include basic figure-ground disturbances and problems with intermodal sensory integration, as well as errors in visual direction and presence of delays in visual processing. These problems can be remediated by visual information processing and perceptual therapy.[11,12]

Tier 4: Non-Vision-Based Problems

Lastly, there are several different and diverse aspects to be considered regarding the numerous non-vision problems in this population. These problems tend to confound and complicate the vision examination procedures as described in tiers 1, 2, and 3.[3,4,8]

These problems must be considered in the overall vision assessment and prognosis

Table 1. Four-tiered Conceptual Model of Optometric Vision Care in Mild Traumatic Brain Injury

I.	**BASIC VISION EXAMINATION**
A.	**Refractive status**
	Distance and/or near lenses
B.	**Binocular status**
	Vision therapy, near lenses, and/or prisms
C.	**Ocular health status**
	Treatment and/or medical referral
II.	**OCULOMOTOR BASED-VISION PROBLEMS**
A.	**Version**
	Vision therapy
B.	**Vergence**
	Vision therapy, near lenses, and/or prisms
C.	**Accommodation**
	Vision therapy and/or near lenses
III.	**NON-OCULOMOTOR-BASED VISION PROBLEMS**
A.	**Abnormal spatial localization**
	Yoked prisms
B.	**Photosensitivity**
	Tints and/or wide brimmed hats
C.	**Motion sensitivity**
	Binasal occlusion, tints, and/or motion desensitization
D.	**Vestibular dysfunction**
	Vision and/or vestibular therapy
E.	**Visual field defect**
	Visual scanning training and/or prisms
F.	**Visual information processing dysfunction**
	Visual information processing and perceptual therapy
IV.	**NON-VISION-BASED PROBLEMS**
A.	**Depression**
	Counseling and/or medications
B.	**Fatigue**
	Nutritional counseling, exercise, and/or adaptive strategies
C.	**Cognitive impairment**
	Cognitive therapy
D.	**Behavioral problems**
	Counseling and/or medications
E.	**Postural problems**
	Yoked prisms, physical and/or occupational therapy
F.	**Attentional problems**
	Cognitive/attentional therapy and/or medications
G.	**Neurological problems**
	Referral to a neurologist

in these patients, especially with respect to any therapeutic invention and its understanding/compliance. These will be briefly considered here.

There are a constellation of non-vision-based problems that may impact adversely on all aspects of the their vision care. For example, cognitive impairment may make the diagnosis and/or therapeutic procedure difficult for the patient to comprehend, and furthermore to be retained in their short-and long-term memory. The same is true for the presence of attentional problems. Fatigue can retard any test and/or therapy, as well as lead to highly variable test results. Many of these patients are depressed, and medications to reduce the depression, or any other medications in general, may adversely affect some of the visual aspects as described earlier (i.e., tiers 1-3). A variety of suggested types of professional consultations, medications, and therapeutic components are listed in Table 1.

In conclusion, we have proposed a conceptual model of optometric vision care for the patient with mild traumatic brain injury. Application of this model should make the task of providing comprehensive and contemporary care relatively simple for the optometrist involved in the diagnosis and treatment of this population.

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