Role of Primary Care Optometrists in the Assessment and Management of Patients with Traumatic Brain Injuries in Canada

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Introduction

Traumatic brain injury (TBI) results from a strong blow or jolt to the head that disrupts the normal function of the brain.[1] The severity of a TBI can range from mild to severe, depending on the patient's mental status, consciousness level and amnesia following the injury. The annual incidence of TBI in North America and Europe is conservatively estimated to be approximately 600/100,000.[2,3] This translates to at least 200,000 TBI cases in Canada every year. According to the Centers for Disease Control and Prevention, and the Canadian Institute for Health Information, the leading cause of TBIs that result in hospital admission is falls (35%-45%), followed by motor vehicle accidents (17%-36%), collision-related events (struck by or against) (10-17%) and assaults (9-10%).[4,5] Head injuries are more common in the 0- to 19-year age group, followed by those who are aged 60+. Males are more highly represented in every age group than females. However, it should be noted that the demographics of patients who present in an optometrist's office may differ from those based on hospital admissions.

TBIs are classified by the duration of loss of consciousness and post-traumatic amnesia, along with the results of brain imaging (Table 1).[6,7] Not all of these signs need to be present. Menon et al. stated that TBI can be diagnosed when there is alteration in brain function defined by any one of the following signs: a period of loss or decreased consciousness, any loss of memory for events immediately before or after the injury, neurologic deficits (weakness, loss of balance, change in vision, dyspraxia paresis/paralysis, sensory loss, aphasia, etc.), and any alteration in mental state at the time of the injury (confusion, disorientation, slowed thinking, etc.).[8]

Common phenomena following a TBI include decreased attention, concentration and processing speed, memory problems, confusion, irritability, depression and anxiety. Physical consequences can include headaches, fatigue, dizziness and nausea, balance difficulties, visual disturbance and sleep disruption.[1] In cases of moderate to severe TBI, patients may also experience decreased executive function, increased confusion, depression, anxiety, lack of impulse control, chronic pain and severe physical consequences.[6] Visual symptoms are observed in 75% of TBI cases.[9] These symptoms can be caused by decreased visual function, disorders of the binocular vision system, changes in ocular health and higher-order processing disorders, which are discussed further below. Due to the broad spectrum of visual symptoms that may occur following TBIs, it is important for the primary care optometrist to be familiar with the testing and management of patients with a history of traumatic brain injury.

Table 1: *TBI Classification System* [6,7]

Characteristic	Mild TBI	Moderate TBI	Severe TBI
Loss of consciousness (LOC)	0 to 30 mins	0.5 to 24 h	>24 h
Post-traumatic amnesia (PTA)	0-1 days	1-7 days	>7 days
Brain-imaging results	Normal	Abnormal	Abnormal

EVALUATION

A thorough ocular-visual assessment (OVA) should be performed for all patients following a TBI. Testing includes a detailed case history, refraction, routine binocular vision and accommodation assessment, automated visual fields and ocular health assessment with dilated fundus evaluation. Additional in-depth testing of some systems should be included in the OVA for patients with a suspected or diagnosed TBI. This includes complementary assessments of the accommodative, vergence and oculomotor systems, and may include visual information-processing testing and visual-midline shift assessment.

The TBI population is also susceptible to cognitive and/or memory impairments, and special consideration should be given when considering the speed and duration of testing. Patients with TBI frequently require more time to process questions and commands. Therefore, objective measurements are preferred, as they will often provide more reliable results.[10] The results of clinical testing should include any reported dizziness, headaches, nausea, or photophobia. If necessary, it may be beneficial to separate the vision examination into two or more appointments.

Case history

A thorough review of visual symptoms should be conducted, which can be facilitated by a symptom checklist completed by the patient prior to the appointment.[11] Case history should include details of the TBI incident and associated injuries. It is useful to review the patient's current and previous rehabilitation services and the progress of their therapy (occupational therapy, physiotherapy, etc.). Patient goals and needs should also be assessed, including their occupational and vocational visual demands, computer use, driving, mobility and reading. Optometrists should remember to record previous ocular conditions and general health (pre- and post-TBI), to differentiate between new and pre-existing conditions.

Visual acuity and refraction

Visual acuity itself is less often affected by TBI, and therefore traditional methods (i.e. Snellen) can be used to assess visual acuity in TBI patients. If a patient has cognitive or communication impairments, modified charts such as a Tumbling E or Broken Wheel test may provide more valid results.[11]

When the optometrist performs a refraction, objective measurements such as retinoscopy should be considered for all patients since it may be difficult to elicit reliable subjective responses. Automated refractors can also be considered for photophobic patients. Although TBIs may not directly change a patient's refractive error, this population may become more sensitive to small prescription changes or uncorrected refractive errors. Special consideration should be given to latent or uncorrected hyperopic patients, who may become symptomatic following a TBI.[12] Progressive addition lenses are not recommended due to peripheral distortions.

Ocular health

A thorough slit lamp examination is performed to assess the ocular health of TBI patients, including a dilated fundus evaluation. Ocular health disorders following TBI can affect the anterior or posterior segments and may include angle recession, dry eye, intraocular hemorrhage or embolisms and papilledema.[13-17] An in-depth assessment of the cranial nerves, pupils and optic nerves should also be performed. Appropriate treatment should be made for the management of these conditions or referral when indicated, such as to the family physician, ophthalmologist, neuro-ophthalmologist, neurologist, etc.

Visual field

Visual field defects may occur through trauma to the optic nerve, chiasm, optic radiations, or occipital cortex.[15-17] Subtle visual field defects may not be detected by confrontational visual field.[18] Automated perimetry is better suited for detecting mild neurological defects and for monitoring changes over time.[18] Screening for visual neglect should also be considered for TBI patients.[19-21] Tests for spatial inattention (neglect) include line bisection and the clock drawing test.[22]

Once appropriate investigation into the visual defect has been completed, treatment therapies are typically aimed at increasing the awareness of the affected field and the development of compensatory techniques. This can be achieved via field-enhancing prisms such as sector prisms, or Peli prisms.[23,24] These prisms are aimed at bringing the image of the affected field into view to provide the patient with information about their periphery. Compensatory functional and rehabilitative techniques can also be taught to patients, such as field scanning, and visuomotor, behavioural and reading techniques.[24,25]

Visual midline shift

Visual midline shift syndrome (VMSS) has been defined as a sense of shifted egocenter and has been reported after brain injuries.[26] It is often associated with, and indeed, may result from, neglect and/or hemianopia, although the exact association has not been documented. These alterations in the perceived midline can create changes in balance and posture. Healthcare professionals who typically address gait and balance include physiotherapists and occupational therapists.[26]

Standardized assessment procedures have not been developed for visual midline shift testing. Current techniques include the subjective alignment of a wand at the midline, eye-hand coordination tests, observation of gait, as well as emerging devices to more accurately quantify the deviation and egocenter.[26] Padula and Argyris stated that a horizontal shift in midline may result in a lateral lean away from the affected visual space, and a possible drift left or right when walking. A vertical shift may result in tilting the body forward or backward (posterior/anterior).[27]

Although further research in this field is needed, practitioners have reported success with the use of compensatory yoked prisms.[26] For assessment, prism lenses are initially placed with the base in the direction opposite the perceived shift in midline, aiming to realign the patient's egocenter. Testing is then repeated with different lenses in place. These trials are usually completed with yoked prisms under 10-12 prism diopters. Spatial localization therapies have also been used to enhance eye-hand coordination. A second approach is prism adaptation, in which localization training is undertaken with prisms in place, with the base contralateral to the direction of the shift. Typically, a higher power of prism is used (17 prism diopters). When the prisms are removed, pointing becomes more central, which can last up to 3.5 years.[28]

Accommodation

Accommodative dysfunctions are present in approximately 40% of TBI patients,[29,30] and include accommodative insufficiency, accommodative infacility, or accommodative spasms (which may induce pseudo-myopia).[31] Accommodative testing should include the assessment of accommodative amplitudes (push-up to blur, or pull away to clear), accommodative accuracy (Monocular Estimation Method, cross cylinder evaluation, or Nott's modified dynamic retinoscopy) and accommodative facility (monocular and binocular).[10]

Management of accommodative disorders may include reading glasses with increased plus at near,[10] or vision rehabilitation exercises.[10,32,33] In non-presbyopic patients, vision exercises are usually recommended as the initial treatment and may include accommodative rock using lenses or different distances, as well as accommodative push-up techniques. There is some evidence that 87-100% of patients with accommodative dysfunctions show improvements with vision therapy.[33]

Binocular vision

Vergence dysfunctions are one of the most common disorders following TBI, and are seen in approximately 50% of patients.[9,29,34] Common disorders include convergence insufficiency (36%), binocular instability (restricted vergence ranges) (10%), basic esophoria (18% of patients with cerebrovascular accidents) and strabismus (e.g., intermittent exotropia, cranial nerve palsy) (7-25%).[9,29,34]

Binocular vision testing should include routine and additional testing, including ocular alignment at distance and near (cover test, Maddox rod, phoria, associated phoria), motor fusion (vergence ranges, near point of convergence, vergence facility with 3BI/12BO prism jumps), sensory fusion (stereoscopy and fusion) and ocular motilities.[12]

Management of vergence disorders may include lenses, correcting prism, or vision therapy exercises.[12,33,35] Vision therapy is usually recommended as the initial treatment for convergence insufficiency, while plus lenses should initially be considered for convergence excess. In-office binocular vision training has been used to successfully treat > 75% of TBI patients with convergence insufficiency.[33,35] These therapies include Brock string, pencil push-ups, prism jumps, or instruments such as the Aperture Rule, cheiroscopes, vectograms and tranaglyphs, often in combination.

Oculomotor

Fixation, pursuits and saccades are affected in approximately 20% of TBI patients.[36] Test procedures that involve oculomotor function include the Developmental Eye Movement Test, King Devick Test, Visagraph/ReadAlyzer goggles with infra-red sensors and the NSUCO (Northeastern State University College of Optometry) and SCCO (Southern California College of Optometry) oculomotor tests.[12]

Treatment is aimed at training each of these individual skills. There is some evidence that oculomotor therapies are successful in improving these skills, especially with reading.[12,33,37] Although training techniques for oculomotor skills have not been extensively researched, therapies can include letter-tracking workbooks, oculomotor pursuit exercises, Brock string fixations, flashlight tag and computerized programs (i.e., Home Therapy System [HTS]) or other computer-aided vision therapy software).

Photophobia

Following a TBI, patients commonly report photophobia and increased sensitivity to glare.[38] Despite its prevalence, photophobia remains poorly understood and is difficult to assess and treat. Ongoing research in this field is performed to better understand the underlying mechanisms. Various theories have attributed photophobia to migraines following TBI, damage to the pain-sensitive intracranial structure and deficits in dark adaptation.[38-40]

For TBI patients, the case history should include questions about increased sensitivity to glare, sunlight, computers and screens.[41] Careful pupil testing should be performed, although this will often yield normal results. Dry eye or headaches should also be investigated, as these conditions may exacerbate photophobia symptoms.[38] All underlying disease should be appropriately treated.

Although no major studies have been conducted on the management of photophobia symptoms, current treatment options include tinted lenses, overlays, and polarized, photochromic or fit-over sunglasses.[41] These options are mostly selected subjectively, but often provide relief to patients and improve their visual comfort. However, there is some evidence that no tint, lighter tints or decreasing the tint over time encourages a decrease in photosensitivity with time.[42]

MULTIDISCIPLINARY APPROACH

It is not uncommon for TBI patients to have comorbid health conditions. A multidisciplinary approach is always recommended when managing these patients. Interprofessional collaboration with other health care providers allows improved patient care through regular progress reports and communications. In addition to optometrists and ophthalmologists, other specialists who are often involved in the care of TBI patients include medical doctors, neurologists, physiotherapists, occupational therapists, audiologists, vestibular therapists, physical therapists and chiropractors. It is recommended that optometrists develop a good relationship with other providers to ensure optimal patient care. Allied healthcare providers should be provided with a report detailing the oculo-visual findings and recommendations for mutual patients.

CONCLUSION

As discussed, visual symptoms are very common following TBI. These patients benefit from a thorough optometric evaluation to identify and manage any underlying vision condition. Treatments may include tinted lenses and overlays, corrective and prismatic lenses, and vision therapy and rehabilitation. Addressing the visual needs of patients with TBI can reduce their symptoms, improve their quality of life and help them return to work and daily living. ●

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