Mild Traumatic Brain Injury: A Prelude to CAPD

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People with mild traumatic brain injury (TBI), as well as survivors of moderate or severe TBI, can face long-term consequences. All central nervous system (CNS) structures are susceptible to damage, especially the auditory cortex (*HJ* Nov. 2009 issue, p. 17).

Worldwide, 42 million people experience a mild TBI each year, with the potential to develop neurodegenerative disease (*Mol Cell Neurosci* 2015;66[part B]:75-80). Mild TBI is a significant public health issue, especially given that 75 percent of head injuries fall into this category, according to the Centers for Disease Control and Prevention (CDC; Report to Congress on Mild Traumatic Brain Injury in the United States: Steps to Prevent a Serious Public Health Problem).

An undetermined number of patients sustain minor head injuries that resolve physically but may cause underlying cognitive or auditory processing changes that go unnoticed and underreported.

MECHANICS AND OUTCOMES

TBIs typically occur from a blow to the head, extreme acceleration or deceleration without head contact, or pressure waves created by an explosion, as seen in returning veterans (*J Rehabil Res Dev* 2012;49[7]:995-1004).

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The most frequent cause of head injuries is falls, followed by unintentional blunt trauma, motor vehicle crashes, and assaults, as noted by the CDC (Traumatic Brain Injury in the United States: Fact Sheet). Seniors and young children, especially males, are most at risk of falls, the CDC added.

Traumatic brain injuries result in deformation of the cortex or brainstem, with mechanical damage occurring at the time of injury (primary injury) or further cell death appearing hours to days after the insult (secondary injury).

It is not uncommon for TBI patients to experience both peripheral and central effects, including hearing loss, central auditory processing disorder (CAPD), tinnitus, dizziness/vertigo, phonophobia and photophobia, auditory hallucinations, seizures, depression and anxiety, post-traumatic stress disorder (PTSD), headaches/migraines, sleep disorders, cognitive and social dysfunction, behavioral aberrations, and suicide attempts.

A TBI can dismantle cohesive brain function, as clearly demonstrated by electroencephalogram (EEG) and emerging neuroimaging techniques (*Neurol India* 2014;62[5]:487-491).

THE AUDIOLOGIST'S ROLE

It is estimated that central auditory processing disorder follows a traumatic brain injury in about 58 percent of cases (*Int J Audiol* 2005;44[1]:39-49). The patient with a severe impairment has obvious physical injuries and telltale findings across modalities, but those with mild TBI may have more subtle or unseen difficulties, requiring an in-depth investigation.

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In the presence of a normal audiogram, otoacoustic emissions (OAEs), impedance, physical examination, MRI, and standard EEG, the diagnosis of CAPD cannot be overlooked.

Take the example of an 18-year-old football player who was hit on the field and had a normal hearing evaluation and physical examination on the first report. Two years after the accident, he was seen for difficulty hearing and fell more than two standard deviations below normal results on the Hearing in Noise Test (HINT), Double Dichotic Digits Test, and the Pitch Pattern Sequence Test.

Because there's such a high incidence of CAPD after traumatic brain injury, audiologists should carefully review a patient's history of head or neck trauma, with specific attention to the severity of the incident, changes in personality and abilities, and the extent of follow-up care or rehabilitation.

For example, a fall greater than 3 feet is considered severe, and chronic headaches or neck and shoulder pain, as well as cognitive issues lasting more than three months, raise suspicions for post-concussion syndrome.

When possible, the audiologist should be able to identify emergency department reports; previous diagnoses; results from MRI, PET, or SPECT scans; evoked potentials and neuropsychology reports; and the patient's rehabilitation activities and outcome measures. In the absence of a complete evaluation, a neurologist and neuropsychologist specializing in TBI are the professionals of choice for starting the process.

A bottom-up audiological assessment for traumatic brain injury may include:

- A hearing evaluation to identify peripheral hearing loss.
- Carefully presented pure tones to identify loudness tolerance issues.
- Impedance with ipsilateral and contralateral acoustic reflexes, if possible, to identify middle ear function, and intra- and extra-axial brainstem abnormalities.
- CAPD evaluation with appropriate measures, such as dichotic tests, low-redundancy speech signals, binaural interaction, and temporal processing.
- Tinnitus assessment.
- OAEs with contralateral masking to evaluate the medial efferent system within the brainstem.
- When available, auditory brainstem response (ABR) and middle latency response (MLR) testing to confirm brainstem integrity and thalamocortical function.
- P300 and the ABR to complex sounds for diagnosis and monitoring of treatment efficacy.

Regardless of the degree of injury, TBI is a complex process that disrupts brain function and quality of life. Central auditory processing disorder can be elusive until evaluated, potentially leaving patients who have mild traumatic brain injury lost in the system and struggling with communication.