



Let's talk about . . .

DIZZINESS AND IMBALANCE AFTER mTBI

This handout is intended as a general introduction to the topic. As each person is affected differently, speak with your health care professional for individual advice.



Key points

- Damage to the vestibular (balance) system can occur with mild traumatic brain injury (mTBI).
- mTBI may damage either the balance-related parts of the inner ear, brain, or both.
- Symptoms depend on which part(s) of the balance system have been damaged.
- Assessment and treatment of dizziness after mTBI needs to be individualized.
- Most people recover completely.
- A minority have persistent ongoing symptoms referred to as post-concussion syndrome (PCS).

What is dizziness and imbalance after mild traumatic brain injury (mTBI)?

Mild traumatic brain injury (mTBI) is a force to the head, either direct (such as a blow to the head) or indirect (such as a force transferred from the body to the head). You do not need to hit your head or lose consciousness to have mTBI. Another word for mTBI is concussion.

Some people who suffer a mTBI can also sustain damage to the vestibular system. The damage may

be either to the peripheral (inner ear) or central (brain) vestibular structures, or both.

“Vestibular” means related to the inner-ear motion sensors and the parts of the brain that interpret the signals from the sensors. The inner ear sensors and brain control balance as well as the way a person experiences the space around them. When these sensors do not work properly, or the brain misinterprets the signals, a range of symptoms – including dizziness and imbalance – may be experienced.

Health professionals use different words depending on which part of the balance system has been affected by mTBI. A problem with the inner ear sensors or the vestibular (8th cranial) nerve leading to the brain is called a peripheral vestibular disorder. A problem in the brain is called a central vestibular disorder. Some people have both a peripheral and central vestibular disorder after a mTBI.

Among those who have had mTBI, dizziness is second only to headache in symptom frequency. About 40 to 60% of non-hospitalized people are dizzy and off balance after head trauma.

Although clinical awareness is growing, vestibular damage from mTBI often stays undiagnosed or underestimated.

Most people recover fully from mTBI. A minority have persistent ongoing symptoms, referred to as post-concussion syndrome (PCS).

What are the causes?

The force to the head of mTBI moves the brain within the skull. This sudden jarring movement may cause injury to the brain's long connecting nerve fibres (axons). The medical term for this shearing process is diffuse axonal injury (DAI). The result is brain tissue changes at a cellular level. It leads to a rapid onset of neurological changes. The body's

vestibular (balance) system may also be damaged leading to dizziness and imbalance.

mTBI can damage either the central (brain) or peripheral (inner ear) vestibular structures or both.

Central causes of dizziness and imbalance after mTBI include:

- central vestibular dysfunction
- vestibulo-ocular reflex (VOR) dysfunction
- visually-induced dizziness
- vestibular migraine

Peripheral causes of dizziness and imbalance after mTBI include:

- benign paroxysmal positional vertigo (BPPV)
- perilymph fistula
- labyrinthine concussion
- secondary endolymphatic hydrops
- vestibular nerve dysfunction
- inner ear bone dehiscence
- temporal bone fracture

Non-vestibular causes of dizziness and imbalance after mTBI include:

- cervicogenic (neck-related) dizziness
- side effects of medication
- anxiety and post-traumatic stress
- low blood pressure upon standing after sitting or lying down (orthostatic hypotension) and related to physical deconditioning
- pituitary dysfunction and subsequent pituitary hormone deficiency
- autonomic dysfunction causing cardiovascular deregulation

What are the symptoms?

Some vestibular symptoms may occur immediately after mTBI. Others may not show up right away. And some symptoms change over time.

The diagnoses affecting the vestibular system and seen as causes of dizziness and imbalance after mTBI each have their own symptom sets:

Symptoms of central vestibular disorders after mTBI:

Central vestibular dysfunction

Central vestibular dysfunction is mostly related to concussion of vestibular structures in the brain stem and cerebellum. Symptoms include nausea with vertigo and imbalance.

Vestibulo-ocular reflex (VOR) dysfunction

The VOR maintains gaze stability during head movement. It is controlled by the cerebellum. The VOR is responsible for stabilizing the eyes when the head moves. Symptoms include some or all of the following:

- a sensation of “lag” with quick head movements
- oscillopsia, which makes it seem as if objects are bouncing in the field of vision
- dizziness
- vertigo
- balance problems
- spatial disorientation, which makes it hard to work out body position, motion, and height relative to the ground
- nausea and vomiting

Visually induced dizziness

Visually induced dizziness is an umbrella term for a group of symptoms resulting from some vestibular disorders. It refers to chronic dizziness or unsteadiness usually brought on by being in busy visual environments or watching movement. Symptoms include some or all of the following:

- dizziness

- unsteadiness
- light-headedness
- disorientation
- nausea
- vomiting
- sweating
- salivation (mouth watering)
- tiredness
- turning pale

Read our handout about visually induced dizziness

Vestibular migraine

Headaches and migraine attacks are common after mTBI with estimates of about 60-80% of people affected. mTBI-related vestibular migraines can change over time. New symptoms can develop, attacks can change from episodic to chronic, along with other changes. Symptoms include some or all of the following:

- recurrent spontaneous vertigo attacks lasting for minutes to several days
- positional vertigo
- visually induced vertigo
- nausea
- sensation of disturbed spatial orientation

Read our handout about vestibular migraine

Symptoms of peripheral vestibular disorders after mTBI

Benign paroxysmal positional vertigo (BPPV)

The hallmark symptom of BPPV is vertigo that lasts less than 60 seconds. mTBI can cause otoconia (tiny crystals of calcium carbonate) to become dislodged from their usual position in the inner ear and fall into one of the fluid-filled semicircular canals. The normal interaction between the fluid and hair cells in the canal is disrupted. The inner ear becomes sensitive to changes in head position it would normally not respond to. This disruption makes you

feel as though you or your surroundings are spinning. This sensation is referred to as vertigo. Most often only one ear is affected (unilateral BPPV).

The vast majority of BPPV resolve with a few repositioning maneuvers. If symptoms persist, other causes and treatments must be explored.

Read our handout about BPPV

Perilymph fistula

Even minor mTBI can result in a tear or rupture in one or both of the oval or round windows of the inner ear. Perilymph fistula can cause both balance and hearing symptoms, usually shortly after the head trauma, including some of all of the following:

- vertigo
- disequilibrium (feeling off-balance or wobbly)
- discomfort with motion
- nausea and/or vomiting
- sudden or progressive sensorineural hearing loss that sometimes gets better or worse (fluctuates)
- tinnitus (ringing, roaring, or whooshing in the ears)
- sensitivity to everyday sounds (hyperacusis)
- a feeling of fullness or running water in the ear

Read our handout about perilymph fistula

Labyrinthine concussion

Labyrinthine concussion refers to a jarring injury to the fluid filled ducts and chambers in the inner ear which contain the balance and hearing receptors. It usually gets better as the brain adapts and regains balance control over weeks or months, a process called vestibular compensation. Symptoms may include some or all of the following:

- vertigo
- postural or gait imbalance
- sensorineural hearing loss
- tinnitus

- nystagmus (rapid involuntary eye movements) often made worse by rapid head movements
- nausea and/or vomiting

Secondary endolymphatic hydrops (SEH)

mTBI can cause a build-up of fluid in the inner ear called SEH. It may happen weeks or months after the injury. Symptoms may come and go and include some or all of the following:

- vertigo
- sensorineural hearing loss
- tinnitus
- feeling of fullness or pressure in the ears

Read our handout about SEH

Vestibular nerve dysfunction

mTBI can cause injury to the vestibular nerve (8th cranial nerve). This leads to the nerve impulses toward the brain not working properly. As a result, the brain does not receive important information from the inner-ear balance sensors needed to maintain good balance. Research suggests that the rotation of the head that happens in connection with mTBI could lead to a stretching of the vestibular nerve, which then leads to impaired function.

Inner ear bone dehiscence

The force of mTBI can result in a tiny hole (called a dehiscence) in one or more of the bony tubes in the inner ear. This is referred to as semicircular canal dehiscence (SCD). Symptoms include a sudden onset of hearing and balance symptoms. People with SCD often hear internal sounds such as their own voice, heartbeat or even eyeball movements.

Read our handout about about SCD

Temporal bone fracture

The temporal (also called petrous) bone is a hard, thick bone at the base of the skull. It is the most complex bone in the human body. It protects many vital structures including the hearing and balance sensors in the inner ear. Vestibular and hearing issues, especially with an oblique fracture (broken

at an angle), are common and may include one or more of the following:

- vertigo
- nystagmus
- conductive or sensorineural hearing loss

How is it diagnosed?

Although clinical awareness is growing, vestibular damage from mTBI often stays undiagnosed or underestimated.

Improvements in testing peripheral vestibular function allow for the diagnosis of inner-ear vestibular disorders that would not have been identified in the past. Unfortunately, however, the wait times for seeing a specialist and comprehensive vestibular testing are usually long. Many people are not diagnosed until many months after their symptoms start.

Health care practitioners may differ in opinion as to what they consider a mTBI and how it is diagnosed. Encountering these different approaches is an extra challenge for those experiencing mTBI symptoms. Also, mTBI research is going ahead rapidly, and new information sometimes does not quickly reach health care practitioners.

Vestibular disorders caused by mTBI may be diagnosed by a primary care doctor, but are more often diagnosed by a specialist such as an otolaryngologist, otologist, neurologist or neuro-otologist. Depending on the severity of the mTBI and its symptoms, evaluation by an audiologist may be helpful to thoroughly assess any damage to the inner-ear balance mechanism or hearing apparatus.

Your doctor will ask about your symptoms. Try to be as specific as possible about your symptoms and when they get better or worse. It may be helpful to keep a health diary.

Your doctor will also ask about your medical history, including any medications you are taking or recently stopped taking and any surgeries you have had. You will be asked about your symptoms and may be questioned about risk factors including

history of migraines, previous mTBI, collision-sport participation, female gender, persistent headaches, amnesia, younger age, history of mood disorder and presence of a learning disorder. Your doctor will also do a thorough physical and neurological exam.

Depending on your symptoms, you may have some of the following diagnostic tests:

- hearing and vestibular function tests; testing the VOR, however, continues to be largely overlooked
- balance tests that measure what happens when you get less input from your visual or proprioceptive systems; for example, by asking you to stand on a soft surface or a moving platform with your eyes closed
- blood tests
- imaging (CT or MRI scans), typically used for central vestibular disorders

Many of the symptoms of vestibular dysfunction caused by mTBI overlap, so your doctor needs to consider all the possibilities before making a diagnosis.

How is it treated and managed?

All assessment and treatment of dizziness after mTBI needs to be individualized. Evaluation by a doctor with specialized knowledge about mTBI is needed to figure out the best course of treatment for you.

mTBI may result in many symptoms, some primary and some secondary. Due to the widely varied nature and severity of symptoms, as well as the underlying causes, there is not one single course of treatment or recovery for dizziness and imbalance after mTBI. A team approach to treatment often works best.

Depending on the diagnosis, treatment may include:

- vestibular rehabilitation therapy
- canalith repositioning procedures (CRP) for BPPV
- avoiding things that trigger symptoms

- lifestyle changes
- medication
- ear injections
- surgery

Dizziness is considered a risk factor for prolonged recovery. Fortunately, all peripheral and most central vestibular signs and symptoms gradually improve over time due to functional recovery or central compensation once a treatment plan is started.

Vestibular rehabilitation therapy (VRT)

Most people seem to benefit from some type of exercise therapy for imbalance and dizziness after mTBI.

VRT will not, however, help those with spells of acute, active, recurrent, spontaneous vertigo – for example the early stages of secondary endolymphatic hydrops (SEH) and vestibular migraine – because the brain cannot adjust to the changing nature of these disorders.

VRT can be used effectively to help in the normalization of vestibular responses when symptoms of dizziness, vertigo, imbalance, or nausea last more than a few days. A family doctor or emergency physician typically makes the referral for vestibular therapy after a thorough medical evaluation of concussion. Your doctor will decide if any clinical tests need to be done before starting VRT.

VRT helps strengthen the bond between the body, eyes, brain, and inner ear for most people. During VRT, your symptoms are intentionally provoked in a safe and controlled way to work towards getting your brain used to what makes you uncomfortable. Its overall goal is to increase quality of life by adapting you to your disorder, decreasing your symptoms and improving your overall function.

Research suggests that rehabilitation programs are most effective when they are customized. The type, frequency, and intensity of effective exercises varies from person to person.

VRT is tailored to your particular disorder and symptoms. Some exercises are specific, such as reducing symptoms to specific movements or visual stimuli. Other exercises may be related to improving your participation in self-care, household responsibilities, leisure activities, sports, driving, or work.

A VRT program may include:

- **Adaptation exercises**

Help coordinate the vestibular ocular reflex (VOR). A properly functioning VOR allows you to keep visual targets in focus even when your head is moving. There are several types of adaptation exercises.

- **Gaze stabilization exercises**

Involve moving your head while keeping your eyes focused on a target. For the exercises to work, you must move your head as quickly as you can while keeping the target in focus (not blurry). It is normal to get a little dizzy or miss the target every now and then.

- **Target shooting exercises**

Work on keeping your head still while moving the eyes, or vice versa.

- **Habituation exercises**

Designed to reset the sensitivity of the nervous system. They help your brain get used to and ignore movements or situations that make you feel dizzy. This is done through repeated, controlled exposure to signals such as certain body movements, visually complex patterns, and busy environments. You may do exercises indoors and outdoors. You may go on short trips to places that trigger symptoms, such as grocery stores or shopping malls.

- **Balance retraining exercises**

Done by standing on different surfaces and with increasingly narrow bases of support. They are helpful for improving steadiness to carry out activities of daily living as well as to lower the risk of falling.

- **Balance exercises with eyes closed**

Help cut dependence on your eyes for balance by encouraging use of the vestibular system.

- **Strengthening exercises**

Improve muscle support of your body.

- **Gait training**

For example treadmill training and relearning to walk over unstable surfaces.

- **Range of motion exercises**

Help if you have been limiting movement of your head or body to minimize dizziness.

- **Learning and practicing strategies**

These help deal with or prevent your symptoms.

- **Breathing and relaxation exercises**

Help regulate the autonomic nervous system (the part of the nervous system that regulates key involuntary functions).

- **Walking and other aerobic activities**

Issues that might lengthen recovery

Some issues may begin to cross over with mTBI symptoms or make your symptoms worse. If you have had previous mTBIs, for example, it is not unusual for recovery to take longer.

Talk about this with your healthcare professional to make sure that you are on the right path towards recovery.

Issues that might lengthen recovery include:

- previous mTBI
- history of migraines
- learning disabilities or attention deficit hyperactivity disorder (ADHD)
- depression or anxiety
- older age
- visual and vestibular abnormalities
- sleep abnormalities

Post-Concussion Syndrome (PCS)

Most mTBI resolve within the first three months. About 15–30% of people still have dizziness and other symptoms beyond three months. They may have PCS and experience persistent ongoing concussion symptoms.

PCS may include the earlier listed emotional, mental, physical and sleep disturbance symptoms as well as some or all of the following:

- social withdrawal or isolation
- erratic emotional responses out of proportion to the situation, including intense fearfulness, anxiety and worrying
- balance problems
- difficulty in busy environments (for example malls, grocery stores, big-box retailers, transit stations)
- problems with patterns or visually busy scenes (for example patterned carpets, windshield wipers or moving hands)
- poor memory
- speech problems
- dysregulation of heart rate, blood pressure (exercise intolerance)

What to expect in the future

Recovery from dizziness and balance after mTBI continues to be an area of emerging research. Evidence-based research on vestibular rehabilitation therapy for mTBI is consistent across studies but the level of research is weak. Although VRT shows promise, high-level studies are needed to work out which treatment strategies are most effective.

Advances in virtual reality (VR) show promise in strengthening the effects of traditional vestibular rehabilitation therapy.

Visit our website

View this and other articles about vestibular disorders – www.balance&dizziness.org.

In addition, find information about how the balance system works, the journey from diagnosis to treatment, building a wellness toolkit, and more.

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