VERTIGO?
LOOK BETWEEN YOUR EARS

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The inner ear is the chief organ of the human balance system. Each inner ear is comprised of three semicircular canals defined by their orientation in space as angle accelerometers, and two further receptors contained in the otolith; the utricle and saccule. The utricle and saccule convey horizontal acceleration and downward pull of gravity information. The balance portions of the inner ear (the vestibular system) are dynamic, in that they respond to linear and angular accelerations in real time. The change over time of their activity is the chief determinant of movement perception. There is a dynamic equilibrium that exists between the inner ears in which a constant resting pattern of signals from each side reaches the brain and is usually equal and opposite in nature, effectively rendering a stable "no significant difference" neural pattern deep in the brain, in an area called the pre pontine reticular formation.

Many different diagnoses can lead to complaints of imbalance in a patient who has sustained an injury. Typically, medical determinants of causation in such patients include the mechanism of injury and nature of symptoms. However, the principles of evidence based medicine can be more accurately applied in patients with post traumatic dizziness by objective testing to determine presence of an inner ear injury.

The brain interprets unequal inner ear input as an indicator of motion, which fits our definition of "vertigo". When there is a change in function in one of the organs of the vestibular system, the unequal intensity of discharges from the inner ear is detected by the brain as an imbalance, and the manifestation of this is typically a sensation of rotary hallucination because the eye muscles are reflexively directed to deviate in a certain direction. The result of this eye position change is called nystagmus.

Objective balance testing holds a unique place in the diagnosis and treatment of patients with dizziness because nystagmus can be recorded and measured. In a medical clinic equipped with a vestibular lab, patients can be tested with the use of state-of-the-art four-channel Video Nystagmography (VNG) in order to objectively record the function of the inner ear balance system and the subserving vestibular nerve.

A two-camera system allows the clinician to control for common unrelated eye muscle abnormalities such as strabismus or convergence insufficiency. The VNG test represents the gold standard in objective vestibular testing, with an established track record. More recent technology can be used to evaluate the function of the inner ear angle accelerometers, the three semicircular canals, in the fast phase component of their action, which may be more physiologically pertinent in dizzy patients. This testing is performed via Video Head Impulse Testing (vHIT), which can measure eye movement velocity and the presence of covert, or hidden, eye position changes (saccades) in response to rapid head position changes.

Vestibular Evoked Myogenic Potential testing (VEMPs) is an objective inner ear balance test which can determine patterns of abnormal functioning in the gravity sensor organs, the otoliths. We have recently published one of the largest studies in the VEMP literature[1] which demonstrated that consistent VEMP test protocols can identify abnormalities in inner ear gravity sensor function in patients complaining about abnormal motion sensitivity, sea sickness or height sensitivity. These types of complaints are often seen post injury, but have not been thoroughly examined prior to the understanding and evaluation of the inner ears' otolithic function.

Injuries can often lead to complaints of disproportionate hearing loss in background noise. Objective assessments using Electrocochleography (ECOG) can identify patterns of "hidden hearing loss", which can point clinicians to more accurate diagnoses and treatments. Finally, state-of-the-art hearing assessments such as the Multiple Auditory Processing Assement (MAPA) use both behavioral audiometric and objective electrophysiologic test protocols to diagnose Central Auditory Processing Disorders (CAPD).

Taken together, with a detailed history and a directed neuro-otologic clinical examination, an experienced neuro-otologist and auditory vestibular team can reasonably be expected to evaluate the integrity of the inner ear hearing and balance system with an unprecedented level of medical evidence.

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1. https://www.tandfonline.com/doi/full/10.1080/00016489.2021.1887517