

# CONCUSSION: VESTIBULAR EVALUATION & TREATMENT

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Dizziness and imbalance are commonly reported symptoms following concussion [1-4] and deficits in these areas are often reported for upwards of 30 days post injury [5,6]. There are numerous diagnostic paradigms that may be considered when evaluating the concussed athlete. Unfortunately, the most commonly utilized vestibular diagnostic evaluation is not especially sensitive to sport-related concussion [7]. The most important metrics for evaluation in the athlete include measurements central integration. This presentation will focus one two of the most consistent abnormalities noted in the vestibular diagnostic laboratory – balance presentation and the functional vestibulo-ocular reflex (VOR) pathway.

Numerous options are available for evaluating balance. In sport-concussion testing, balance is often evaluated using bedside techniques such as the Balance Error Scoring System (BESS) [8-11]. Computerized balance tests using forceplate technology increase our ability to objectively evaluate the concussed athlete and monitor recovery. Generally, these tools evaluate the ability to maintain stable balance by synchronizing information from the visual, vestibular, and somatosensory systems. Objective balance measurement protocols include conditions which evaluate the athlete's ability to effectively use these three conditions for stable balance. While forceplate technology may increase the objectivity of the evaluation, static postural ability may not be the most sensitive metric for evaluating athletes [12], especially when no baseline data are available for comparison. Modifications to the standard evaluation that add dynamic conditions have been shown to increase the sensitivity of computerized balance testing for those with motion-induced balance complaints [13-15] and those with head injury [16].

A simple method of evaluating the vestibular system is to functionally assess the VOR pathway. The VOR is a reflexive eye movement that occurs after vestibular system stimulation. This reflex stabilizes images on the retina during angular or translational head movements. In brief, the vestibular system detects head movement and sends neural impulses to drive the eyes in the opposite direction. In those with impaired vestibular systems, the VOR pathway cannot function correctly, leading to an inability to maintain stable vision – i.e., oscillopsia. Symptoms associated with VOR pathway dysfunction include increased dizziness:

- With quick head turns
- In busy visual environments, e.g., grocery stores, shopping malls, in hallways between classes
- When in motion, e.g., walking, running on a treadmill, in the car
- When taking notes in class, working on the computer, reading [17]

Dynamic visual acuity (DVA) testing is a method used to functionally evaluate the VOR pathway and ascending central integration components. DVA testing is performed by comparing the difference between static visual acuity and visual acuity obtained during fixed-velocity head movement. Following sport-related concussion, the peripheral vestibular system is generally functioning appropriately; however, a high proportion of athletes demonstrate abnormalities on functional VOR tasks. For example, Zhou & Brodsky [18] noted reduced dynamic visual acuity in over half of pediatric athletes. This suggests that the abnormalities noted on functional VOR testing may result from central integration impairments, likely at the level of the brainstem or cerebellum [18-21]. This addition to concussion management can be done simply by using a vision chart or tablet / phone application, or by using a computerized method which monitors head direction and velocity.

Vestibular rehabilitation is a significant component for post-concussion management. Identification of underlying abnormalities, such as abnormal oculomotor or vestibular function, can lead to targeted rehabilitation methods with improved recovery trajectories [22]. Several intervention options may be used post-concussion depending on the patient's clinical presentation. Management for positional vertigo (BPPV) is common in those post-concussion. Management of this disorder is completed using canalith repositioning maneuvers; rehabilitation specialists specializing in this demonstrate significantly improved symptoms. Additional therapies addressing imbalance as well as dizziness associated with visual motion sensitivity and gaze stability (VOR dysfunction) have demonstrated strong efficacy [20,21,23, 24].

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\*Posters available on request.

L E F O D P C T 1

F D P L T C E O 2

P E Z O L C F T D 3

E D L T O Z F C P 4

L P C F E T O D Z 5

T F D O P Z L E C 6

Z C T L O P D F E 7