Consideration of a Neuromotor Concussion Subtype

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Abstract: A recent Consensus Conference proposed subtyping concussive injuries into 5 categories. We propose adding a neuromotor subtype. Abnormal motion is a key feature of brain injury, as concussions can impact the neurological systems controlling gait. Neuromotor function can remain abnormal after symptom resolution and may be superior to self-report for tracking recovery. Neuromotor function can also define co-occurring orthopedic injuries and reveal vulnerabilities which could reduce injury risk.

Keywords: Concussion; Gait assessment; Head injury; Neuromotor subtype; Traumatic brain injury

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In 2016, a Consensus Conference provided guidelines for the evaluation of patients experiencing a potential concussion [1] from which a framework to define concussion subtypes, and concussion-associated conditions was derived [2]. Based on a metanalysis, five concussion subtypes were identified: Cognitive, ocular-motor, headache/migraine, vestibular, and anxiety-mood [2]. Each subtype includes a defined prevalence and the measurements used for analysis. These consensus guidelines are a significant advancement that can aid in identifying, evaluating, and following patients with suspected brain injury. We propose that a neuromotor, gait-specific subtype could be an important addition to this nosology, and could result in clinicians and researchers better articulating and assessing the neuromotor consequences of concussion.

There are several justifications for considering a gait concussion subtype and conducting a formalized assessment of gait. First, a sizable portion of the brain is involved in supporting motion. Second, gait abnormalities have been identified as an acute symptom of concussion [3,4]. Third, because concussions can be caused by a wide range of events including athletic and recreational injuries, motor vehicle and bicycle crashes, falls, altercations, intentional self-harm, and work-related accidents [5,6], the sequelae of such events may be equally heterogeneous. In fact, concussions can include sensory symptoms such as numbness, dizziness, or instability, and the neuromotor consequences of these symptoms would help to more fully capture the extent of the injury, localize the site of injury, and inform recovery [7]. Moreover, neurological patterns of gait can capture neuromuscular, orthopedic, and biomechanical complications that can co-occur with concussion [8]. For example, gait asymmetries, variability, shuffling, apraxia, or unsteadiness represent some of these gait characteristics, though they may be extremely subtle and invisible to an inexpert observer.

Another advantage of including a formal gait evaluation is that it provides information separate from the patient’s self-report. In contrast, the concussion framework forwarded in 2016 relies heavily on self-reports, with headache/migraine and anxiety-mood subtypes being solely based on self-reported symptoms. Consequently, the objective evaluation of neuromotor function could complement self-reported symptoms, and is especially relevant for those with difficulty communicating their symptoms (e.g., children, dementia patients) or those trying to manipulate the evaluation (e.g., personal injury claimants who are malingering, or athletes eager to return to sport) [9]. Because locomotion is an automatic, unconscious activity [10], the automaticity of walking and balance while walking are often implicated in concussions, such that these automatic and unconscious activities may require conscious awareness and effort to function normally [10]. Because gait is mainly unconscious, patients may be less aware of gait-related dysfunction or the extent to which conscious control over gait is being exerted due to declines in gait automaticity.
Although there are some exceptions (e.g., NIH 4-Meter gait test, The Up and Go test), objective measurements can be quantitatively compared to baseline data and relative to population-based norms. Identifying characteristic deviations from these norms, particularly in the context of sub-concussive injuries, could provide an early warning of functional change before disabilities become permanent. This is especially relevant given that multiple sub-concussive events may predispose one to significant future brain injury [17].

When considering injury prevention, it’s important to note that numerous factors can underlie the risk of experiencing an injury, and this can include proper gait form and degree of effort or fatigue [18]. Thus, poor gait technique during exertion can amplify underlying vulnerabilities in our anatomy and posture. Rehabilitation of poor gait technique is essential after a concussive injury because subliminal compensatory patterns may produce poor habits and increase the likelihood of secondary injury. A gait evaluation can identify the proper technique, compensatory patterns, and maladaptive habits for such variables as gait symmetry, speed, variability, and energy expenditure. With this gait profile, athletic trainers and physical therapists can tailor a treatment program to reduce the risk of future injury. Moreover, subtle changes can be quantified and tracked to illustrate progress and areas needing further or alternative interventions.

In summary, concussions are heterogeneous injuries and a neuromotor (gait) subtype is an essential feature missing from the current nosology of concussion. Its inclusion as a concussion subtype could improve screening, diagnosis, treatment, and injury prevention.

References