CRITICAL REVIEW

Neuropsychology and clinical neuroscience of persistent post-concussive syndrome

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Abstract

On the mild end of the acquired brain injury spectrum, the terms concussion and mild traumatic brain injury (mTBI) have been used interchangeably, where persistent post-concussive syndrome (PPCS) has been a label given when symptoms persist for more than three months post-concussion. Whereas a brief history of concussion research is overviewed, the focus of this review is on the current status of PPCS as a clinical entity from the perspective of recent advances in the biomechanical modeling of concussion in human and animal studies, particularly directed at a better understanding of the neuropathology associated with concussion. These studies implicate common regions of injury, including the upper brainstem, base of the frontal lobe, hypothalamic-pituitary axis, medial temporal lobe, fornix, and corpus callosum. Limitations of current neuropsychological techniques for the clinical assessment of memory and executive function are explored and recommendations for improved research designs offered, that may enhance the study of long-term neuropsychological sequelae of concussion. (JINS, 2008, 14, 1–22.)

Keywords: Concussion, Mild TBI, Biomechanics, Neuroimaging, Neuropathology, Neuropsychology

INTRODUCTION: BRIEF HISTORY OF CONCUSSION

That concussion occurs and is commonplace is not in dispute. The United States Government's Center for Disease Control (CDC) estimates that there are more than one million concussions that occur annually in the United States, using their definitional statement of concussion being a condition "of temporarily altered mental status as a result of head trauma (www.cdc.gov, see Rutland-Brown et al., 2006)."

What is controversial is whether one fully recovers without symptoms from having sustained a concussion. Given the commonness of concussions along with the adaptive nature of brain function combined with neural plasticity (Duffau, 2006; Girza & Prins, 2006; Moucha & Kilgard, 2006; Priestley, 2007), it might be assumed that any transient impairment as a result of concussion would not result in any neurological sequelae. Indeed, historically the original Latin term "commotio cerebrī" was used to describe concussion, thought to occur because of "traceless disturbances" that produced momentary functional impairment without any damage to brain tissue (see reviews by McCrory & Berkovic, 2001; Vos et al., 2002). Hence, for decades, one of the venerable definitions in standard neurology textbooks, exemplified by the following quote from Grinker's Neurology was as follows: "the usual patient loses consciousness briefly, soon recovers and thereafter is without symptoms" (Vick, 1976; p. 651). In that concussion was thought to be mostly benign, the non-biological and psychodynamic theories that dominated the beginnings of clinical psychology and psychiatry minimized the effects head injury could have on behavior. This is captured by the 1947 quote by Page (1947) in an abnormal psychology textbook that "head injuries and gunshot wounds involving damage to the brain occasionally produce mental disturbances, but such injuries are not an important cause of mental disease (p. 330)". Persistent maladaptive symptoms in this time frame were believed to be more an expression of a "neurosis" than anything possibly "organic." So,