POST-CONCUSSION EFFECTS ON NEUROCOGNITIVE PERFORMANCE IN TACTICAL ATHLETES

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Concussion is a concerning injury and recovery can last days, weeks, or even months. Becoming familiar with post-concussion symptoms and the ensuing health-related sequelae is essential for those aiming to optimize the physical performance of tactical athletes.

The brain conducts an array of complex tasks orchestrated by approximately 100 billion interconnected neurons responsible for processing information with amazing speed and accuracy (4). The ability to process visual stimuli, negotiate obstacles, coordinate posture and locomotion, and react to varying external stimuli are just a few examples of tasks simultaneously modulated by the brain along with other central nervous system structures. Tactical athletes are trained to respond rapidly, safely, and effectively to a myriad of dangerous and stressful situations that demand high workloads and mental acuity. Optimal neurocognitive performance and physical capacity are needed for successful occupational performance. The significance of the brain’s neuro-operating system may be taken for granted until neurocognitive performance decrements manifest following head trauma.

Identifying neurocognitive deficits resulting from mild traumatic brain injury (mTBI) may improve the safety and effectiveness of tactical athletes. An mTBI or concussion following head trauma can deleteriously affect short- and long-term neurocognitive performance. mTBI may occur during rapid movement of the brain inside the skull and may result from physical impact with an object or other sudden energy transfer to the body (e.g., blast wave). Presentation of one or more of the following symptoms is used to define mTBI: headache, nausea, vomiting, dizziness, balance issues, confusion, disorientation, loss of consciousness for less than 30 min, amnesia, blurred vision, and difficulty concentrating (8). These symptoms may represent post-concussive syndrome (PCS), and may continue for days, weeks, or months. Persistent PCS is diagnosed when at least three of the following eight clinical manifestations persist for more than one month: 1) fatigue; 2) alterations in sleep; 3) irritability or aggression; 4) anxiety, depression, and emotional distress; 5) headache; 6) vertigo; 7) changes in personality; and 8) apathy or loss of spontaneity (7). Understandably, tactical personnel with PCS will have duty restrictions set forth by qualified health professionals. It is important to know that exercise too soon following mTBI is not advised and can result in re-injury, delayed recovery, and the return of PCS symptoms (5). Untreated PCS can increase the risk for long-term neurocognitive health issues and compromise the safety of the tactical athlete (e.g., learning disability, Alzheimer’s disease, musculoskeletal injury, etc.) (6).

Tactical athletes must be prepared to endure physical and psychological stressors, often in austere, unfamiliar, and dangerous environments. Tactical athletes must remain physically fit and are often required to meet minimum cut-off standards of physical fitness (17). For this reason, injury related dysfunction of either physical or neurocognitive domains can potentially threaten physical readiness, survivability, and long-term health. Neurocognitive performance, in the context of athletic performance, has been defined as visual attention, self-monitoring, agility and fine motor skills, processing speed and reaction time, and dual tasking (2). Thus, effectively executing neurocognitive and physical tasks simultaneously (multitasking) has a direct impact on the tactical athlete’s physical capacity and job performance. Physical capacity, or ability, dictates the workload that can be tolerated before fatigue ensues. Physical capacity can be influenced by factors such as the nature of the work, somatic factors (e.g., age, health, etc.), psychological factors, environmental factors (e.g., heat, altitude, noise, etc.), and training adaptations (1). Physical capacity is also associated with physiological regulation, neuromuscular control, and motor learning, all of which are modulated by sensory processing, attention, and motor planning (2). All of this suggests that deficits in neurocognitive function, such as those seen with PCS, may put the tactical athlete at an increased risk for musculoskeletal injury.

This was observed by Nordstrom et al. in a study that examined short- and long-term sequelae of concussion in 1,665 elite European football (soccer) players over a 12-year span (13). The study reported that concussion was a significant risk factor for subsequent injury. Of the 1,665 players, 71 concussions were reported among 66 players. In the year following the concussion, the risk of injury was progressively higher in concussed vs. non-concussed players. Risk of injury in concussed players was 1.56, 2.78, and 4.07 (hazard ratios) at 0 – 3 months, 3 – 6 months, and 6 – 12 months, respectively. A study by Pietrosimone et al. utilized a survey instrument to examine the association of concussion with musculoskeletal injuries in 2,552 retired American football players from the National Football League (NFL) (15). After adjusting for NFL years played, body mass, and playing position, the risk for lower extremity musculoskeletal injuries was 1.59, 2.29, and 2.86 times higher in players reporting 1, 2, and 3 or more concussions,
respectively, versus players reporting zero concussions. These data may indicate that more sensitive neurologic and cognitive assessments, in conjunction with current clinical guidelines, are warranted to determine return-to-duty criteria.

Currently, a battery of physical and cognitive assessments are utilized to evaluate mTBI (8). Recently, several studies have examined the utility of integrating diagnostic protocols with greater sensitivity to PCS (3,9). This is achieved by measuring how well a concussed patient can perform two or more tasks simultaneously (specialized balance and cognitive tests). Parker et al. observed (up to 4 weeks post-concussion) that concussed subjects walked slower, and displayed greater sway and sway velocity while concurrently performing simple mental tasks compared to uninjured controls (14). It is possible that altered gait kinematics may be one of many factors that influence higher risk for lower extremity musculoskeletal injuries in concussed individuals. In addition to the application of more sensitive assessment tools, treatment therapies are also being investigated.

Depending on the severity of mTBI, cell damage or death can occur due in part to mitochondrial (an important cellular component responsible for sustaining life) damage and dysfunction (10). In damaged cells there is reduced adenosine triphosphate (ATP) production and less nitric oxide (NO) diffusing out of the cell. Treatment involving exposure to red or near infrared (NIR) light-emitting diode (LED) has been shown to increase NO in the fluid surrounding hypoxic cells, resulting in vasodilation and increased regional blood flow (12,16). After this exposure, NO diffuses out of the cell and promotes increased blood flow and increased ATP production, which can lead to improved oxygenation and cell function. Recently, the use of red/NIR LED gained attention as a potential treatment for mTBI based on research showing that some red/NIR light can penetrate through a human cadaver scalp and skull (approximately 1 cm) tissue (18).

A case study involving a military retiree with a history of multiple mTBIs revealed promising outcomes of transcranial LED treatment. The retiree had been on medical disable for five months prior to treatments. After four months of nightly, home LED treatments, he was able to return to full-time employment (10). In a study conducted by Naeser et al., 11 subjects who presented with PCS (10 civilian cases and one blast TBI case) were treated with LED (11). LED treatment was applied to specific areas of the scalp for 20 min three times per week for six weeks. The LED treatment resulted in a trend toward neurocognitive improvement, with no adverse events or negative side effects reported. Moreover, patients with posttraumatic stress disorder (PTSD) reported less intense PTSD symptoms and better sleep quality following the LED treatment. The one subject who suffered a blast TBI (three years prior to the transcranial LED treatments) was able to return back to his duties in his military unit.

Tactical athletes must be physically fit and demonstrate a high degree of neurocognitive function. mTBI is a serious injury and tactical athletes must be evaluated by qualified healthcare professionals if a suspected head injury has occurred. PCS negatively impacts the tactical athlete’s ability to perform multitasking operations and may leave them at a greater risk of musculoskeletal injury. Returning to duty before PCS has completely resolved can potentially compromise safety, increase injury risk, and result in long-term neurocognitive deficits. New, more sensitive mTBI assessment protocols and therapy strategies aim to improve PCS recovery and return-to-duty. Tactical facilitators need to be aware of the factors, signs and symptoms, and consequential risks involved for tactical athletes dealing with mTBI and PCS to refer them to a certified healthcare professional when needed. Investigating more in depth and sensitive mTBI assessment tools that can be used in conjunction with current clinical guidelines, as well as emerging concussion treatment modalities, may help improve recovery and facilitate return-to-duty.

PRACTICAL CONSIDERATIONS:

• mTBI is a concerning injury and tactical athletes must be evaluated by qualified healthcare personnel if a suspected head injury has occurred.

• PCS may present subtle symptoms beyond 7 – 10 days, during which time the tactical athlete could be at greater risk for musculoskeletal injury.

• New assessments are currently being examined that aim to better identify PCS and neurocognitive performance by assessing the ability to perform physical and mental tasks simultaneously.

• Emerging PCS therapy, such as red/NIR LED, show promise for improving symptoms of PCS and return-to-duty.

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REFERENCES


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