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Original Article

Sleep Disorders Associated With Mild Traumatic Brain Injury Using Sport Concussion Assessment Tool 3

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ABSTRACT

BACKGROUND: Sleep problems affect 30% to 80% of patients with mild traumatic brain injury. We assessed the prevalence of sleep disorders after mild traumatic brain injury and its correlation with other symptoms. **METHODS AND MATERIALS:** Individuals with mild traumatic brain injury were assessed at the New York University Concussion Center during 2013-2014 with the Sports Concussion Assessment Tool, third edition, data following mild traumatic brain injury. The relationship between sleep problems (drowsiness, difficulty falling asleep, fatigue or low energy), psychiatric symptoms (sadness, nervousness or anxiousness), headache, and dizziness were analyzed by Spearman correlation and logistic regression using moderate to severe versus none to mild categorization. **RESULTS:** Ninety-three patients were retrospectively considered. The most common injury causes were falls (34.4%) and motor vehicle accidents (21.5%). There was a positive correlation between dizziness, headache, psychiatric problems (sadness, anxiety, irritability), and sleep problems (fatigue, drowsiness, and difficulty falling asleep) ($P < 0.001$). Logistic regression showed a significant association between moderate to severe psychiatric symptoms and moderate to severe sleep symptoms ($P < 0.05$). Sleep symptoms became more severe with increased time interval from mild traumatic brain injury to Sport Concussion Assessment Tool 3 administration (odds ratio = 1.005, 1.006, and 1.008, $P < 0.05$). There was significant correlation between motor vehicle accident and drowsiness and difficulty falling asleep ($P < 0.05$). Medications given in the emergency department had a positive correlation with drowsiness ($P < 0.05$). **CONCLUSIONS:** Individuals who report moderate to severe headache, dizziness, and psychiatric symptoms have a higher likelihood of reporting moderate to severe sleep disorders following mild traumatic brain injury and should be counseled and initiated with early interventions.

Keywords: TBI, sleep disorders, SCAT3, comorbidity

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Introduction

Traumatic brain injury (TBI) is one of the major causes of death and disability throughout the world, particularly among children and young adults. The primary causes of TBIs are falls, motor vehicle accidents, being hit by objects, and assaults.[1] Recent Centers for Disease Control data show that, of the 1.6-3.2 million TBIs that occur in the United States each year, the majority are classified as mild TBI (mTBI) or concussions.[2]

Estimates of sports-related mTBI range from 1.6 to 3.8 million affected individuals annually in the United States, many of whom do not obtain immediate medical attention.[2] The most common symptoms of sports-related concussion include headache, dizziness, confusion, nausea, memory difficulties, "mental fogginess," fatigue, balance problems,

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attention and concentration difficulties, sleep disturbances, and "nervousness".[3,4]

The prevalence of sleep disorders in individuals with TBI is very high, yet mostly unrecognized. Recent research suggests that 30%-70% of patients experience sleep problems and fatigue following TBI.[5-7] Brain regions and systems regulating arousal, alertness, attention, and sleep are vulnerable to TBI.

The Sport Concussion Assessment Tool (SCAT) is a paper neurocognitive tool that was initially developed at the Second International Conference on Concussion in Sport in Prague in 2005 by combining existing tools.[8] It includes a postconcussion symptom scale and three tests evaluating cognitive abilities.

Although the SCAT is a widely used tool, application of this neurocognitive test in terms of evaluation of sleep disorders in persons with concussion has never been tested. The purpose of the study was to evaluate the prevalence of sleep disorders following mTBI and its correlation with other symptoms using SCAT third edition (SCAT3).

Subject and Methods

Data from participants who sustained a concussion and were referred to the New York University Concussion Center 2 days to 3 years after concussion (mean 135 days) for assessment and management in 2013-2014 were retrospectively collected. Inclusion criteria were the presence of mTBI and available SCAT3 tool. Incomplete data were deleted.

mTBI was defined as an admission Glasgow Coma Scale score of 13-15, loss of consciousness or altered mental state that lasted <20 minutes, absence of focal neurological deficits, and post-traumatic amnesia that lasted <24 hours.[9]

The relationship between symptoms of sleep disturbances (drowsiness, difficulty falling asleep, fatigue or low energy), psychiatric symptoms (sadness, nervousness or anxiousness), headache, and dizziness was analyzed by Spearman correlation and logistic regression analysis using moderate to severe versus none to mild categorization for symptoms.

Each patient completed a baseline questionnaire that included questions about demographics, past concussions, previous injury, and sport participation history. The SCAT3 score as well as results of King-Devick (KD) test, Standardized Assessment of Concussion (SAC), and Balance Error Scoring System (BESS) test were evaluated. A description of these instruments appears in Table 1.

The study received approval of the Institutional Review Board and New York University Ethics Committee before commencement. Because it was a retrospective data collection study, consent was not obtained.

Statistical analysis and sample size calculations

The relationship between sleep problems (drowsiness, difficulty falling asleep, fatigue or low energy), psychiatric symptoms (sadness, nervousness or anxiousness), headache, and dizziness was analyzed using Spearman correlation and logistic regression using moderate to severe versus mild to none categorization. The medical history, mechanism of concussion, KD test, SAC, and BESS score were analyzed. No sample size calculations were performed because it was a retrospective study and the number of participants depended on the number of patients who completed the tools used in the study.

Results

The data of 93 patients (median age 31 ± 16 years, 41 males) were analyzed. The most common mechanisms of injury leading to concussion were falls (34.4%) and motor vehicle accidents (21.5%). A substantial proportion of the patients (50.5%) had sport-related concussions (Table 2).

Most of the patients with concussion reported psychiatric and sleep disorders with the predominance of headache (53.8%), fatigue (49.5%), drowsiness, difficulty falling asleep, and irritability (31.2%) (Figure).

There was a positive correlation between dizziness, headache, psychiatric problems (sadness, anxiety, irritability), and sleep problems (fatigue, drowsiness, and difficulty falling asleep) ($P < 0.001$). Patients with moderate to severe psychiatric symptoms were associated with moderate to severe sleep symptoms. Logistic regression showed a significant association between moderate to severe psychiatric symptoms and moderate to severe sleep symptoms (odds ratio > 1, $P < 0.05$). All three sleep symptoms became more severe with increased time interval from mTBI to SCAT3

TABLE 1.
Description of Test Instruments Used in the Study

Questionnaire	Details
Sport Concussion Assessment Tool[8]	Concussion evaluation tool for individuals 13 years and older Consists of subjective sections assessing the presence of 25 symptoms on a seven-point Likert scale Objective section includes signs, modified Maddocks questions, symptom score, cognitive assessment, and neurological screening
Balance Error Scoring System[10,11]	Noninstrumented clinical tool for assessing balance Six 20-second balance tests in three stance conditions (double leg, single leg, tandem stance) on firm and compliant surface A higher error score indicates a more severe postural instability
Standardized Assessment of Concussion[12]	Objective tool to assess mental status Used during sporting events Measure orientation, immediate memory, concentration, and delayed recall Assessment of muscle strength, sensation, and coordination, as well as loss of consciousness and amnesia
King-Devick test[13,14]	Consists of a series of charts of numbers that progressively become more difficult Assesses eye movement, language function, and attention as a function of suboptimal brain function Usually employed in conjunction with other concussion tests to enhance presence of concussive injury