

Understanding Brain Damage and Sleep Apnea: A Review

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ABSTRACT

Sleep disturbances affect practically every segment of society, permeating across all ethnic, socioeconomic, and age groups. According to the American Academy of Sleep Medicine, there are more than 90 different sleep disorders. One of the most commonly diagnosed sleep disorders is sleep apnea. There are 3 types of sleep apnea: central, mixed, and obstructive sleep apnea (OSA). Sleep-disordered breathing is extremely prevalent in the brain-injured patient population. OSA is the most common type of apnea and is easily alleviated with continuous positive airway pressure. However, if left untreated, OSA can induce and exacerbate cognitive deficits and other metabolic disorders. It has been established that OSA is a risk factor for cerebrovascular accidents and cardiovascular outcomes. Patients with brain injury have existing lesions that are exposed to episodic/intermittent hypoxia if accompanied by OSA. The ubiquitous nature of OSA poses a threat to brain-injured patients, and treatment of sleep apnea is warranted to avoid further complications that might prolong recovery and time in rehabilitation. The purpose of this article is to increase awareness among physicians in order to improve the management of patients with brain injury and OSA. We will review the current concepts, prevalence, and ramifications of sleep apnea in brain-injured patients and their cognitive function.

KEYWORDS: Brain; Sleep apnea

The Centers for Disease Control and Prevention estimates that at least 3.17 million Americans require long-term care and help to perform daily activities as a result of a traumatic brain injury (TBI).¹ It has been shown that episodic hypoxia during sleep-disordered breathing (SDB) may cause permanent brain changes and can start early in the progression of sleep disorders, even in childhood. This might worsen in patients with existing brain injury and cause more potential damage to cognitive and motor function.² Sleep apnea can pose a serious threat to an individual's psychological and physiological well-being. OSA can cause a plethora of problems, the most important of which, for the purpose of this review, are cognitive deficits. Recent research has shown that OSA is extremely prevalent in the brain-injured patient population. Treatable sleep disorders appear to be common in the TBI population, but are largely undiagnosed and untreated.³

An apnea is defined as complete pauses in breathing that last at least 10 seconds during sleep. Most pauses last between 10 and 30 seconds, but some may persist for 1 minute or longer. This can lead to abrupt

reductions in blood oxygen saturation, with oxygen levels falling as much as 40% or more in severe cases. The brain responds to the lack of oxygen by alerting the body, causing a brief arousal from sleep that restores normal breathing. This pattern can occur hundreds of times in one night.⁴ Sleep apnea is classified based upon respiratory disturbance index (RDI: number of apneas, hypopneas, and respiratory-related arousals in 1 hour); an RDI of 5 or greater is consistent with the diagnosis of OSA and appears to be common in adult subjects with TBI.⁵

THE BRAIN AND SLEEP

Sleep is one of the most important biological functions and, as such, it is important to understand the normal functioning of the brain during sleep in order to fully appreciate what it means to have abnormal sleep patterns. A person with normal sleep patterns goes through numerous sleep cycles, with each cycle comprised of stages rapid eye movement (REM) and NREM (non-REM). REM sleep is initiated by signals sent from the area of the brain called the pons. The signals then move to a part of the brain called the thalamus, which then sends the information to the cerebral cortex; the outer layer of the brain that plays a critical role in normal human learning, thinking, and organization of information.⁶ During each stage, specific types of brain waves, including alpha, theta, spindles, and k complexes, indicate what is happening in the brain.

Good sleep hygiene is important for many reasons. During deep sleep, the brain releases growth hormones that are critical for normal child development.⁶ Many different parts of the brain contribute to sleep. Areas of the brain like the suprachiasmatic nucleus and the pineal gland are responsible for, among other things, secretion of melatonin; a neurotransmitter that plays an important role in initiating and maintaining sleep.⁶

Sleep is also extremely important for normal central nervous system functioning. Not getting enough sleep can leave a person drowsy and unable to focus or concentrate. It may also impair a person's memory and physical performance and reduce one's ability to perform math calculations.⁶

BRAIN INJURY

The United States Centers for Disease Control and Prevention estimates the following statistics; annually:⁷

- At least 1.56 million people sustain a TBI
- Approximately 50,000 people die from a TBI
- Approximately 475,000 TBIs occur among infants, children, and adolescents aged 0-14 years
- About 80,000-90,000 people experience the onset of a long-term disability due to a TBI

Brain injury is usually classified as either primary or secondary. Primary injury is the direct result of head trauma, whereas secondary is the result of complications later on, such as infection, hypoxia, or hypertension.⁸ Under the primary injury category, there are various types of injuries, including concussion, contusion, and diffuse axonal injury.⁸ Concussions are usually considered mild traumatic brain injury and are not usually fatal. A concussion does not always include unconsciousness. Any blow to the head that causes amnesia, confusion, or any neurological deficits can be considered a concussion.⁸ Cerebral contusions are usually the result of a sudden jolt that causes either the frontal lobes or occipital lobes to make contact with the skull. Close neurological observations must be made over a period of time to ensure that there are no further complications, which many times require surgery.⁸ Axonal damage commonly occurs in the corpus callosum but is not limited to that area. Hemorrhaging may occur and it is often accompanied by other types of primary head injuries.⁸

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