

Chronic traumatic encephalopathy and football

Abstract

Chronic traumatic encephalopathy (CTE) is a deterioration of the brain. This neurodegenerative disease is a result of repeated blows to the head, which lead to the buildup of an abnormal protein called tau. CTE can develop months or years after the last head trauma. CTE is most commonly seen in athletes, specifically football players. Chronic traumatic encephalopathy is associated with memory loss, Parkinsonism, impaired judgment, dementia, aggression, depression and suicidality. Certain areas of the brain are liable to atrophy but diagnosis can only be made at autopsy. The frequency of CTE in the population is not yet known and there currently is no cure for CTE.

Keywords: chronic traumatic encephalopathy, head trauma, tau protein, neurodegenerative disease, nfl, football players

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Abbreviations: CTE, chronic traumatic encephalopathy; NFT, neurofibrillary tangles; TDP-43, TAR DNA-binding protein 43

Introduction

Many pathologic studies have tackled the trend of neurodegenerative disease in professional athletes. Such association is noted in boxers, football players, wrestlers and athletes prone to repetitive head trauma.¹ Many football-related concussions are associated with rapid recoveries, while some players will develop chronic traumatic encephalopathy (CTE).² At large, many individuals prone to repetitive head trauma may be at risk for CTE. The prevalence and incidence of CTE is currently unknown owing to the need of larger and controlled studies on the phenomenon.

Discussion

CTE in at-risk individuals may manifest years or decades following recovery head trauma,³ and is associated with symptoms of irritability, apathy, impulsivity, aggression, depression, memory loss and suicidality.⁴ Later in this degenerative disease, declining cognition, Parkinsonism, speech, ocular abnormalities and dementia may emerge.² Stage I symptoms of CTE include headache and poor concentration; stage II includes depression and memory loss. Cognitive impairment and decreased ability to make decisions were involved in stage III and dementia and aggression were characteristic in stage IV.⁵ Stages I-IV are progressive staging of pathology seen in chronic traumatic encephalopathy.

Upon gross examination, neuropathological findings include: enlargement on the lateral and third ventricles, atrophy of the medial temporal lobe, cerebral hemispheres, mammillary bodies, thalamus and shrinkage of the brainstem. Anterior cavum septum pellucidum, pallid substantia nigra and hippocampal sclerosis, are also a common features seen in CTE.^{2,6} Microscopically, CTE is characterized by neuronal loss and gliosis and dense neurofibrillary tangles (NFTs) in the superficial cortical laminae (II and III). Tau NFTs are found throughout medial temporal lobe, diencephalon, basal ganglia, subcortical white matter and brainstem. [F-18] FDDNP has a high

affinity for tau fibrils, which allows for a high binding potential for visualization in vivo. Dense deposits of tau are consistently found in subcortical areas of the brain as well as limbic areas of frontal and temporal lobes. The neuropathology distribution observed because of [F-18]FDDNP PET imaging are due to paired helical filament-tau, TDP-43 and amyloid- β contributions.⁷ [F-18]FDDNP distribution patterns in football-related CTE are unique among neurodegenerative diseases. Recent studies on athletes with repetitive head trauma found widespread TDP-43 immunoreactive inclusions in the anterior horns of spinal cords. These TDP-43 proteinopathy findings associated with CTE suggest that the pathological accumulation of both NFTs and TDP-43 from repetitive axonal injury provokes neurodegeneration and cell death.

A number of case reports describe a possible connection between CTE and death-by- suicide. In earlier studies before 2013, diagnosis of CTE was achieved only after autopsy. In an effort to identify CTE before death, former NFL players volunteered for a study where tau-binding chemical was injected into the players and PET brain-imaging was used to study brain activity.⁶ Five former NFL players showed an abnormal tau buildup in the area of the brain that controls memory, emotion and attention. Dr. Bennet Omalu was the first to identify CTE in an NFL player and documented that the brains of four professional football players, who committed suicide, showed signs of tau buildup and displayed major depression, neuropsychiatric and cognitive impairments.^{8,9} During the three years after Dr. Omalu's 2010 discovery, six former NFL players with cognitive and psychological impairments died of self-inflicted wounds.

There are no biomarkers for the diagnosis of CTE; however, advances in neuroimaging will conceivably detect subtle changes in axonal integrity in acute CTE. Emerging brain imaging data using [F-18]FDDNP PET is promising for detection of tauopathy in living athletes susceptible for CTE⁷ which may allow for confirmation of CTE without the need of post mortem analyses. The specific identifiable known cause of the neurodegenerative dementia in CTE is head trauma. It is not known whether a single blow to the head is sufficient to cause CTE because all of the cases studied have had a history of multiple head injuries. Headgear that absorbs more shock,

removing the three point stance, adhering to strict “return to play” guidelines after concussions and reducing intentional blows to the head are all examples of exposure limitation to trauma.

Conclusion

CTE is a neurodegenerative disease that appears later in the lives of some individuals with a history of rehashed head injury. At present, neuropathological examination of brain tissue is the only way to diagnose the psychological and cognitive symptoms associated with CTE. Ongoing research on football players with suspected CTE use fibrillar insoluble protein aggregates and PET imaging with the aim of establishing signals indicative of fibrillar neuroaggregates in retired football athletes. There is a need for comprehensive cognitive and autopsy-based research performed longitudinally efforts to identify biomarkers that detect the disease and monitor its progression, and to develop therapies to slow, stop or reverse its course.

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Conflict of interest

The author declares no conflict of interest.

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