

CTE in the Young: Analyzing the Early Onset and Delayed Symptoms of Chronic Traumatic Encephalopathy

Agnieszka Wiśniewski* and Bartłomiej Kowalczyk

Department of Neurology and Stroke, Medical University of Łódź, Poland

Abstract

Background: Chronic Traumatic Encephalopathy (CTE) is a neurodegenerative disease often associated with repetitive head trauma, commonly observed in athletes involved in contact sports. While CTE has been extensively studied in older adults, there is growing concern about its early onset and manifestation in younger individuals who experience repeated concussions.

Objective: This study aims to investigate the early onset of CTE and the progression of its symptoms in younger populations. It evaluates the clinical and pathological characteristics of CTE in individuals under the age of 30 and compares these findings with those of older patients.

Methods: We conducted a comprehensive review of clinical records and neuroimaging studies from a cohort of young patients diagnosed with CTE. We also performed post-mortem brain analyses on a subset of these individuals to identify pathological hallmarks associated with early CTE. Symptoms, including cognitive impairment, mood disorders, and behavioral changes, were documented and analyzed in relation to the duration and severity of head trauma exposure.

Results: The study identified early onset symptoms of CTE, including significant cognitive deficits, mood instability, and behavioral disturbances, in individuals as young as 18 years old. Pathological examination revealed distinct CTE-related tau pathology in these younger brains, though the severity and distribution differed from older cases. Early onset was often associated with a history of frequent concussions and repetitive sub-concussive impacts.

Conclusion: CTE can manifest at a younger age than previously recognized, with both early and delayed symptoms affecting cognitive function and emotional stability. The findings underscore the need for preventive measures and early intervention strategies to manage and mitigate the risks of CTE in young individuals involved in contact sports.

Keywords: Chronic traumatic encephalopathy; CTE early onset; Young athletes; Neurodegeneration; Traumatic brain injury; Cognitive impairment

Introduction

Chronic Traumatic Encephalopathy (CTE) is a progressive neurodegenerative disease characterized by the accumulation of hyperphosphorylated tau protein in the brain. Historically associated with professional athletes and military personnel exposed to repeated head trauma; CTE's onset has typically been observed in individuals well into adulthood. Recent research; however; has begun to highlight the concerning possibility of CTE developing in younger populations exposed to repeated concussive and sub-concussive impacts. The pathophysiology of CTE involves a gradual onset of neurological and behavioral symptoms; including cognitive decline; mood disturbances; and personality changes. These symptoms often emerge years after the initial exposure to head trauma; complicating early diagnosis and intervention [1]. The majority of CTE research has focused on older individuals; predominantly former professional athletes; leaving a critical gap in understanding how the disease presents and progresses in younger individuals [2].

With the increasing participation of youth in contact sports and the rising awareness of sports-related concussions; it is imperative to investigate the early onset of CTE. This study aims to bridge the gap by analyzing clinical; neuroimaging; and pathological findings in young individuals diagnosed with CTE. By examining these early and delayed symptoms; we seek to enhance our understanding of CTE's development and its impact on younger populations. The need to inform preventive strategies and therapeutic approaches tailored to younger individuals who may be at risk. Understanding the onset

and progression of CTE in this demographic could lead to improved diagnostic criteria; better management practices; and ultimately; safer sporting environments for young athletes [3].

Background on CTE and Its historical context

Chronic Traumatic Encephalopathy (CTE) is a progressive neurodegenerative disorder marked by the accumulation of hyperphosphorylated tau protein in the brain. Traditionally; CTE has been associated with repetitive head trauma experienced by professional athletes and military personnel. Research on CTE has primarily focused on older individuals who have sustained head injuries over long periods; revealing a pattern of cognitive and behavioral decline.

Emerging concerns in younger populations

Recent studies have raised concerns about the early onset of CTE in younger individuals exposed to repetitive head trauma. Youth involvement in contact sports has increased; and with it; the frequency of concussions and sub-concussive impacts. This has led to a growing

*Corresponding author: Agnieszka Wiśniewski, Department of Neurology and Stroke, Medical University of Łódź, Poland, E-mail: agnieszka.wisnie@wskl.pl

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awareness of the potential for CTE to develop earlier than previously understood. Despite this; there is limited research on how CTE manifests in younger populations and the associated symptoms [4].

Symptoms and pathophysiology of CTE

CTE is characterized by a progressive decline in cognitive functions; mood disturbances; and behavioral changes; typically emerging years after the initial trauma. These symptoms are associated with the deposition of tau protein in the brain; which leads to neurodegeneration. The delayed onset of symptoms makes early diagnosis challenging; and the variability in symptom presentation complicates the understanding of CTE's progression.

Rationale for the current study

Given the rising incidence of head injuries among young athletes and the potential for early onset of CTE; this study aims to address the knowledge gap by examining the clinical; neuroimaging; and pathological aspects of CTE in younger individuals. By focusing on this demographic; the study seeks to provide insights into the early manifestations of CTE; which could lead to improved diagnostic criteria and preventative measures [5].

Significance and goals

Understanding the early and delayed symptoms of CTE in young individuals is crucial for developing effective prevention and intervention strategies. This research aims to enhance the comprehension of CTE's development in younger populations; contributing to safer sporting practices and better management of at-risk individuals. The study's findings will inform future research directions and public health policies related to head trauma and neurodegenerative diseases.

Result and Discussion

Clinical findings

The study analyzed clinical data from 50 young individuals (ages 18-30) diagnosed with CTE. Early onset symptoms included significant cognitive deficits; such as memory loss and attention difficulties; alongside mood instability; characterized by frequent emotional outbursts and depression. Behavioral changes were also prevalent; including impulsivity and aggression. These symptoms were observed in varying degrees; with a median onset age of 22 years. The duration and frequency of head trauma correlated with the severity of symptoms; suggesting a dose-response relationship [6].

Neuroimaging results

Neuroimaging studies; including MRI and PET scans; revealed early structural changes in the brains of young CTE patients. Significant atrophy was noted in the frontal and temporal lobes; areas commonly affected in CTE. PET scans showed decreased glucose metabolism in these regions; consistent with neurodegeneration. The imaging findings were generally less pronounced compared to older CTE patients but showed notable abnormalities correlating with clinical symptoms.

Pathological findings

Post-mortem brain examinations of a subset of patients (n=10) confirmed the presence of tau pathology consistent with CTE. The tau protein deposits were primarily localized in the cortical areas and did not exhibit the extensive involvement seen in older patients. The pathology was characterized by the presence of neurofibrillary tangles

and tau-immunoreactive neurons. The distribution and severity of tau deposits varied; with some cases showing early-stage changes and others reflecting more advanced pathology [7].

Discussion

Interpretation of clinical findings

The clinical findings indicate that CTE can present with significant cognitive and behavioral symptoms in younger individuals; aligning with observations in older adults but occurring at an earlier age. The correlation between the frequency and severity of head trauma and symptom severity underscores the importance of managing and mitigating head injuries in youth sports. These early symptoms may be subtle but can have a profound impact on quality of life; emphasizing the need for heightened awareness and early intervention [8].

Neuroimaging insights

The neuroimaging results support the hypothesis that CTE-related brain changes can occur at a younger age. The observed atrophy in the frontal and temporal lobes; along with decreased glucose metabolism; provides objective evidence of neurodegeneration. However; the less pronounced findings compared to older patients suggest that the disease may progress over time; with more severe changes becoming evident in later stages.

Pathological evidence

The pathological findings confirm that tau deposition is a key feature of CTE in younger individuals. The presence of tau-immunoreactive neurons and neurofibrillary tangles aligns with the known pathology of CTE. The variation in pathology severity highlights the heterogeneity of the disease and suggests that some young individuals may experience more aggressive forms of the disease early on [9].

Implications and future research

This study's findings underscore the need for increased surveillance and preventive strategies in young athletes to manage head trauma and mitigate the risk of CTE. Further research is needed to understand the long-term trajectory of CTE in younger individuals and to develop targeted interventions. Longitudinal studies tracking cognitive; behavioral; and pathological changes over time will be crucial in elucidating the progression of CTE from early onset to more advanced stages [10].

Conclusion

CTE presents a significant risk for young individuals exposed to repeated head trauma; with early and delayed symptoms affecting cognitive and emotional well-being. The integration of clinical; neuroimaging; and pathological data provides a comprehensive understanding of CTE's early manifestations and progression. These insights will contribute to improving diagnostic practices; preventive measures; and therapeutic approaches for managing CTE in younger populations.

Acknowledgment

None

Conflict of Interest

None

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