Perspective

Understanding and Confronting Neurodegenerative Diseases

Mohaddeseh Kaplan†

Descritpion

Neurodegenerative diseases are a group of disorders characterized by the progressive degeneration and dysfunction of neurons in the brain and nervous system. These conditions, such as Alzheimer's disease, Parkinson's disease, and Huntington's disease, have a significant impact on individuals' cognitive and motor functions, leading to a decline in quality of life. This article explores the complexities of neurodegenerative diseases, including their underlying mechanisms, common symptoms, and current research efforts.

The key features of many neurodegenerative diseases is the abnormal accumulation of proteins in the brain. Misfolded proteins, such as beta-amyloid and tau in Alzheimer's disease, alpha-synuclein in Parkinson's disease, and huntingtin in Huntington's disease, form aggregates that interfere with neuronal function and lead to neuronal death. These protein aggregates are often associated with specific brain regions affected by the disease, contributing to the characteristic symptoms.

■ Genetic and environmental factors

While the exact causes of most neurodegenerative diseases remain unknown, both genetic and environmental factors play significant roles in their development. Certain gene mutations, such as the *APOE* gene in Alzheimer's disease or the *LRRK2* gene in Parkinson's disease, increase the risk of developing these disorders. Additionally, environmental factors, including exposure to toxins, traumatic brain injuries, and lifestyle factors like diet and exercise, can influence disease progression and onset.

Alzheimer's disease is the most prevalent neurodegenerative disorder, characterized by progressive memory loss, cognitive decline, and behavioral changes. The accumulation of beta-amyloid plaques and tau tangles in the brain disrupts communication between neurons, leading to memory impairment and cognitive deficits. As the disease progresses, individuals may experience difficulties with language, judgment, and daily activities.

Parkinson's disease primarily affects the motor system and is characterized by the degeneration of dopaminergic neurons in the substantia nigra region of the brain. This leads to motor symptoms such as tremors, bradykinesia (slowness of movement), rigidity, and postural instability. Non-motor symptoms, including depression, sleep disturbances, and cognitive impairment, may also be present. The accumulation of alpha-synuclein protein in the form of Lewy bodies is a pathological hallmark of Parkinson's disease.

Researchers are actively investigating the underlying mechanisms of neurodegenerative diseases to identify potential targets for therapeutic interventions. Advances in

Department of Biomedical Engineering, Tufts University, Medford, USA
†Author for Correspondence: Mohaddeseh Kaplan, Department of Biomedical Engineering, Tufts University, Medford, USA
email: kapalnmohaddeseh@gmail.com

Mohaddeseh Kaplan

neuroimaging techniques, such as Positron Emission Tomography (PET) and Magnetic Resonance Imaging (MRI), have enabled the visualization and quantification of protein aggregates, facilitating early diagnosis and monitoring disease progression. Animal models and cell culture studies also play a crucial role in unraveling disease mechanisms and testing potential therapeutic strategies.

■ Emerging therapeutic strategies

While there is currently no cure for neurodegenerative diseases, various therapeutic strategies are being explored. These include approaches to reduce protein aggregation and enhance protein clearance, promote neuroprotection and neuroregeneration, and modulate inflammation and oxidative stress. Additionally, deep brain stimulation and gene therapies are showing promise in managing symptoms and potentially slowing disease progression. Clinical trials are underway to assess the safety and efficacy of these novel interventions.

Neurodegenerative diseases pose significant challenges to individuals, families, and healthcare systems worldwide. However, through ongoing research efforts, we are gaining a deeper understanding of the mechanisms underlying these disorders, as well as identifying potential risk factors. This knowledge is crucial for the development of effective treatments and interventions that can alleviate symptoms, slow disease progression, and improve the quality of life for individuals living with neurodegenerative diseases. While much work remains to be done, the advancements in research and the exploration of new therapeutic strategies offer hope for a future where the impact of these devastating conditions can be minimized.