Article type: Editorial

Home Page URL: https://www.alliedacademies.org/immunology-case-reports/

Microglia in motion: Guardians of the brain or agents of disease?

Natasha Tales*

Department of Immunology, Benaroya Research Institute, United States

Correspondence to: Natasha Tales, Department of Immunology, Benaroya Research Institute, United States, E-mail: natashatales@york.ac.uk

Received: *02-Apr-2025, Manuscript No. AAICR-25-171199;* ***Editor assigned:*** *03-Apr-2025, Pre QC No. AAICR-25-171199(PQ);* ***Reviewed:*** *18-Apr-2025, QC No. AAICR-25-171199;* ***Revised:*** *24-Apr-2025, Manuscript No. AAICR-25-171199(R);* ***Published:*** *30-Apr-2025, DOI: 10.35841/aaicr-8.2.199*

Introduction

Microglia, the resident immune cells of the central nervous system (CNS), have long been recognized as the brain's vigilant sentinels. Derived from yolk sac progenitors during early embryogenesis, these dynamic cells continuously survey the brain's microenvironment, responding to injury, infection, and developmental cues. Traditionally viewed as neuroprotective, microglia are now understood to play dual roles—both protective and pathological—depending on context and activation state. This duality has sparked intense scientific interest: are microglia guardians of the brain, or agents of disease? In the healthy brain, microglia exhibit a ramified morphology, extending and retracting processes to monitor neuronal activity and synaptic integrity [1].

Synaptic pruning during development, refining neural circuits by eliminating excess synapses. Phagocytosis of apoptotic cells and debris, maintaining tissue cleanliness. Secretion of neurotrophic factors, supporting neuronal survival and plasticity. These functions underscore their role as custodians of CNS homeostasis. Disruption of microglial surveillance can impair neurodevelopment and contribute to cognitive deficits. Upon detecting danger signals—such as pathogens, trauma, or protein aggregates—microglia transition to an activated state. This involves morphological changes, proliferation, and the release of inflammatory mediators like cytokines, chemokines, and reactive oxygen species [2].

While acute activation is essential for defense and repair, chronic or dysregulated activation can be detrimental. Prolonged inflammation may lead to: This paradox positions microglia as both protectors and potential perpetrators in CNS pathology. Microglial dysfunction is implicated in several neurodegenerative disorders: Microglia respond to amyloid-β plaques by clustering around them, attempting clearance. However, chronic activation leads to sustained inflammation and neuronal loss. Genetic variants in microglial genes, such as *TREM2*, influence AD risk and progression [3].

In PD, microglia react to α-synuclein aggregates, releasing pro-inflammatory cytokines that exacerbate dopaminergic neuron degeneration. Targeting microglial activation is a potential therapeutic strategy. Microglia in ALS exhibit a shift from neuroprotective to neurotoxic phenotypes, contributing to motor neuron death. Modulating microglial polarization may slow disease progression. Emerging evidence links microglial activity to psychiatric conditions: Aberrant synaptic pruning by microglia during adolescence may underlie cognitive and behavioral symptoms. Altered microglial function affects neural connectivity and social behaviour [4].

Neuroinflammation mediated by microglia is associated with mood dysregulation and treatment resistance. These findings suggest that microglia influence not only neurodegeneration but also neurodevelopment and mental health. Microglia exhibit remarkable plasticity, adopting diverse phenotypes based on environmental cues. The classical M1/M2 dichotomy—pro-inflammatory vs. anti-inflammatory—is now considered overly simplistic. Instead, microglia display a spectrum of activation states, including: Maintain surveillance and support. Identified in AD, characterized by upregulation of phagocytic and lipid metabolism genes [5].

Conclusion

Citation: Tales N. Microglia in motion: Guardians of the brain or agents of disease?. Immunol Case Rep. 2025;8(2):199.

Microglia are indispensable guardians of the brain, orchestrating immune defense, synaptic remodeling, and tissue repair. Yet, under pathological conditions, they can become agents of disease, driving inflammation and neurodegeneration. Their dual nature reflects the complexity of CNS immunity and underscores the need for nuanced therapeutic approaches. As research continues to unravel microglial biology, the goal is clear: harness their protective potential while curbing their destructive tendencies—ensuring that these vigilant cells remain allies in brain health.

References

1. Wang H, Peters T, Kess D, et al. Activated macrophages are essential in a murine model for T cell–mediated chronic psoriasiform skin inflammation. J Clin Invest. 2006;116(8):2105-14.
2. Nestle FO, Conrad C, Tun-Kyi A, et al. Plasmacytoid predendritic cells initiate psoriasis through interferon-α production. J Exp Med. 2005;202(1):135-43.
3. Nestle FO, Turka LA, Nickoloff B. Characterization of dermal dendritic cells in psoriasis. Autostimulation of T lymphocytes and induction of Th1 type cytokines. J Clin Invest. 1994;94(1):202-9.
4. Nickoloff BJ, Wrone-Smith T. . Injection of pre-psoriatic skin with CD4+ T cells induces psoriasis. Am J Pathol. 1999;155(1):145-58.
5. Bullard DC, Scharffetter-Kochanek K, McArthur MJ, et al. A polygenic mouse model of psoriasiform skin disease in CD18-deficient mice. Proc Natl Acad Sci. 1996;93(5):2116-21.

Citation: Tales N. Microglia in motion: Guardians of the brain or agents of disease?. Immunol Case Rep. 2025;8(2):199.