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A Review of Nanotechnology-Based Innovations in Multiple Sclerosis Diagnosis and Treatment

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Introduction

MS is a complex disease with a variety of physiologic and pathologic processes and pathways. The immune system targets the myelin sheath that protects nerve cells in the brain, spinal cord, and optic nerve in MS patients. The nerve cells are unable to conduct electrical signals adequately due to the damaged and impaired nerve membrane, resulting in limb numbness, paralysis, blindness, and other neurological diseases [1]. The primary goal of this paper is to highlight recent advances in nanotechnology that have allowed clinicians to overcome the blood-brain barrier and target the brain and CNS of multiple sclerosis patients.

We've concentrated on using nanotechnology with therapeutic and imaging components to improve tissue imaging, molecular targeting, nerve protection, and regeneration therapy. We also talked about the disease's pathophysiology and innovative nanotechnology-based ways for delivering therapeutic possibilities for MS diagnostics and treatment. Future advancements in the creation of novel practical therapy techniques for the treatment of MS are now being investigated.

Multiple sclerosis (MS) is also known as encephalomyelitis and disseminated sclerosis. It's an autoimmune and inflammatory disease in which the body's immune cells assault the nervous system, producing demyelization and the destruction of myelinated axons in the CNS, resulting in slowed nerve signals. The diagnosis of disease is made based on the patient's clinical symptoms as well as supportive data from MRI of the brain and cerebrospinal fluid investigation [2]. Multiple sclerosis (MS) is also known as encephalomyelitis and disseminated sclerosis. It's an autoimmune and inflammatory disease in which the body's immune cells assault the nervous system, producing demyelization and the destruction of myelinated axons in the CNS, resulting in slowed nerve signals. The diagnosis of disease is made based on the patient's clinical symptoms as well as supportive data from MRI of the brain and cerebrospinal fluid investigation.

Description

Pathophysology

The main cause of harm in MS is inflammation of the central nervous system (CNS). MS is characterised by plaques of demyelinated nerve cells in the CNS. Incorporation of genetic variables, environmental factors, and infectious organisms can all influence the development of MS, according to studies, yet the fundamental factor causing inflammation remains unknown [3-5]. The experimental autoimmune encephalomyelitis (EAE) animal model has been widely employed in immunological research to investigate the roles of multiple immune pathways involved in MS. MS patients' brains and spinal cords have been found to have abnormally high levels of iron and other redox elements.

Innate and adaptive immune responses are two forms of immune responses that both play a role in the course of this neurological condition. Microbial compounds trigger the innate immune response by activating particular toll-like receptors (TLR) in an antigen-agnostic way. The binding of these antigenic molecules to TLR causes an increase in the generation of cytokines, which modulates the adaptive immune response further. The innate system controls T and B cell effector function and has a role in illness start and progression. Dendritic cells begin to polarise CD4+ T cells to develop into Th1 as they mature. When T cells convert into a Th1 phenotype from Th2 or Th17 phenotypes, inflammation is encouraged The presence of lymphocytic cells within plaques and other surrounding areas shows that antigen-specific targeting of myelin protein and other CNS components is the primary mode of inflammatory destruction in MS. With the help of stronger contrast and better focused molecular imaging probes, nanotechnology-based systems are employed to improve neuroimaging power. It can also be integrated into modern biosensor systems within the brain to investigate circuit physiology principles. Current approaches for detecting debilitating CNS illnesses can be considerably improved by utilising the unique and better physical, chemical, and biological features of nanomaterials, and new insights into brain physiology can be exploited to generate novel therapy strategies.

Pomegranate seed oil was supplied in the form of micro droplet formulation in an animal study and showed promising results in multiple sclerosis and autoimmune encephalitis The use of carbon nanowires and nanotubes in neuronal repair and regeneration is currently being investigated. They have an effect on cellular signal transmission, and have shown promise in improving cerebrovascular dysfunction following brain tumours, diagnosing and treating brain disorders, and enhancing neuronal cell function inside brain tissues.

Conclusion

Various developments in the field of MS medication delivery systems have been developed throughout the previous few decades. Although various medications have been approved for the management and treatment of the condition, an enhanced drug delivery system is necessary to deliver the drugs in the local vicinity of the required target site. This challenge has been partially handled by colloidal DDSs such as liposomes, emulsomes, and solid lipid nanoparticles.

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