

Neural Stem Cell-Derived Extracellular Vesicles Modulate Microglial Polarization and Enhance Functional Recovery in Spinal Cord Injury

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Abstract

The inflammatory cascade following spinal cord injury (SCI) impairs axonal regeneration. We investigated the immunomodulatory properties of neural stem cell (NSC)-derived extracellular vesicles (EVs) in a contusion SCI rat model. Systemic administration of NSC-EVs at 24 hours post-injury shifted microglia/macrophages from pro-inflammatory M1 to anti-inflammatory M2 phenotype, evidenced by reduced iNOS and elevated Arg1 expression. EV cargo analysis revealed enrichment of miR-124 and miR-145, which target MCP-1 and TLR4 signaling pathways. Treated animals demonstrated improved Basso-Beattie-Bresnahan (BBB) locomotor scores, enhanced serotonergic fiber sprouting, and reduced glial scar formation. NSC-EVs represent a cell-free, immunologically inert therapeutic for SCI.

Keywords: neural stem cells, extracellular vesicles, spinal cord injury, microglial polarization, miR-124, immunomodulation



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