

## I. Introduction

Spinal Cord Injury, or SCI, is characterized by damage to the spinal cord. Symptoms of SCI include a loss of motor and sensory function, extending to organ dysfunction and disrupted homeostatic control. SCI, a widespread condition affecting various aspects of day-to-day functioning, can occur in a number of ways: affecting around 15 million people currently across the globe, non-traumatic causes of SCI include infection, congenital disorders, degenerative disease, and tumors, while physical accidents constitute the majority of traumatic causes (World Health Organization: WHO, 2024). The unpredictable and universal nature of physical accidents contributes to the prevalence of SCI events, as they could happen to anybody, regardless of age or gender (*How Many People Are Affected by SCI?*, 2025). Despite such extensiveness, SCI remains a topic with much uncertainty and significant potential for further research, with no current treatment able to induce the reversal of spinal cord damage.

Exosomes, which are extracellular vesicles (EVs) containing cellular material, play a role in communication between cells, influencing physiological functions such as immune response, tissue growth, and neurological function. These EVs are able to be extracted for specific and targeted delivery to a desired cell or tissue. Consequently, exosomal therapies show promise in treating SCI, with evidence of prevention of cell apoptosis, promotion of tissue and nerve regeneration, and reduction of inflammation (Chen et al., 2025). Exosomes can be derived from various sources, most notably, from humans, microbes, animals, and plants (Amina et al., 2024). More specifically, exosomes are commonly sourced from mesenchymal stem cells, neural cells, macrophages, and placenta, and are administered through the bloodstream, intramuscularly (through the muscle), intranasally (through the nose), or sublingually (under the tongue).

Of the above methods, intranasal administration is distinct, as it is non-invasive, easily passes through the blood-spinal cord barrier (BSCB), and circulates in the bloodstream for an adequate amount of time compared to quickened kidney filtration or hepatic uptake (Wang et al., 2025). This makes the exosome notably accurate and effective in its delivery. Furthermore, exosomes derived from bone marrow mesenchymal stem cells (BMSCs) were found in past studies to suppress TLR4/MyD88/NF- $\kappa$ B, a pathway which promotes inflammation and, further, cell death in extreme cases (Fan et al., 2021). Thus, BMSC-derived exosomes, in hindering this

pathway, produce the opposite effect: anti-inflammatory and antiapoptotic properties.

## **II. Specific Aim**

In this study, the aim is to test the ability of BMSC-derived exosomes, administered intranasally, in reducing inflammation, regenerating damaged tissue, and improving motor function for individuals with SCI.

## **III. Rationale**

In the past, studies have been conducted using BMSC-derived exosomes administered intranasally, but studied mice, and tested other pathogens; none to date have tested BMSC-derived exosomes' effect on humans with SCI.

## **IV. Methods**

In this study, 20 individuals with various spinal cord injury types and severities will be recruited and closely monitored over a period of 6 months.

During these 6 months, the changes in inflammation, damaged tissue, and motor function will be quantified using each patient's before-and-after measurements as their own control.

The starting condition of the patient's inflammation will be measured using magnetic resonance imaging (MRI). The amount and severity of damaged tissue will be quantified using both MRI and the International Standards for Neurological Classification of Spinal Cord Injury (ISNCSCI). Lastly, the motor function of the patient will be measured using various physical tests including walking, muscular, mobility, and balance tests.

Once a week, each patient will be sprayed intranasally with BMSC-derived exosomes using intranasal spray from Apex Medical, in equal amounts into both nostrils.

After the 6 months, changes in the amount of inflammation, damaged tissue, and motor function will be measured again with the tests above.

## **V. Pitfalls and Approaches**

A possible pitfall is the inability to randomize patients' spinal cord injury severity, as the timeframe between the SCI incident and the administration of exosomes may determine their effectiveness.

## References

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