Oral Communication

OC-929

# Modulating Neuroplasticity in Sensorimotor Cortex and Spinal Lesion Sites via Multi-Target Magnetic Stimulation Promotes Motor Function Recovery in Rats After Spinal Cord Injury

**Topic:** Neurostimulation (rTMS, tDCS, etc.)

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## BACKGROUND

The core challenge in motor functional recovery following spinal cord injury (SCI) stems from the irreversible damage to neural circuits induced by neuronal death, axonal disruption, and secondary inflammatory cascades within the lesioned area. While neuromodulation techniques can promote neuroplasticity, conventional single-target approaches (e.g., stimulating solely the cortex or peripheral) yield suboptimal functional recovery due to their failure to co-activate ascending and descending pathways in sensorimotor circuits.

## METHODS

Adult male Sprague-Dawley (SD) rats were randomized into four experimental cohorts and received T10 spinal cord clip compression injury: (1) sham surgery + sham stimulation group, (2) sham stimulation group, (3) nerve root magnetic stimulation (NRMS) group, and (4) neural circuit magnetic stimulation (NC-MS, combined motor cortex transcranial magnetic stimulation and NRMS) group. This study investigated the therapeutic effects of early multi-target magnetic stimulation (initiated on postoperative day 3) on corticospinal functional reorganization and motor recovery. Adult male Sprague-Dawley (SD) rats were randomized into four experimental cohorts and received T10 spinal cord clip compression injury: (1) sham surgery + sham stimulation group, (2) sham stimulation group, (3) nerve root magnetic stimulation (NRMS) group, and (4) neural circuit magnetic stimulation (NC-MS, combined motor cortex transcranial magnetic stimulation and NRMS) group. This study investigated the therapeutic effects of early multi-target magnetic stimulation (initiated on postoperative day 3) on corticospinal functional reorganization and motor recovery. The study employed behavioral tests to assess hindlimb motor function; electrophysiological recordings to test neural conduction in motor pathways; and biochemical assays (Western blotting, Synaptic electron microscopy, Immunofluorescence, etc.) to systematically evaluate structural and functional changes in the spinal cord and cortex.

## RESULTS

The study found that magnetic stimulation significantly improved motor recovery in rats compared to the control group, and shortened motor evoked potential latency post-SCI. In the sensorimotor cortex, synaptic activity zones expanded, dendritic density increased, and synaptic plasticity markers (PSD95, GAP43, Synapsin I) were upregulated. In the spinal lesion area, neuronal damage was reduced, glial scar formation attenuated, and neuroplasticity markers (PSD95, GAP43, BDNF) increased, accompanied by decreased pro-inflammatory CD68 and elevated anti-inflammatory markers (CD206, CCR7). Critically, multi-target stimulation (NC-MS) group demonstrated superior efficacy to single-target stimulation (NRMS) group.

## CONCLUSION

Neural circuit magnetic stimulation may alleviate damage, improve neuronal function, and restore motor recovery via microglial M1/M2 modulation, corticospinal activation, and neurotrophic signaling. This study demonstrates multi-target magnetic stimulation promotes motor recovery post-SCI through coordinated immunomodulation and circuit plasticity, informing targeted neuromodulation therapies.

**Statement of Disclosures**

None

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**Doi:** 10.5606/archisprm.2026.OC-929