

# Editorial for “Functional Reorganizations Outside the Sensorimotor Regions Following Complete Thoracolumbar Spinal Cord Injury”

Augustus Waller published the concept of antegrade axonal degeneration following nerve injury in experimental study of frogs in 1850.<sup>1</sup> The concept of retrograde degeneration of spinal tracts in proximal axon and nerve cells has also been studied for many years.<sup>2</sup> The advent of magnetic resonance imaging (MRI) and advanced imaging techniques allowed multiple studies in animals and also in human subjects. Many previous publications have established extensive upstream atrophic and microstructural changes in corticospinal axons and sensorimotor cortex following acute and chronic spinal cord injury (SCI).<sup>3</sup>

Multiple previous studies have surmised that structural changes of the brain following SCI go beyond sensorimotor cortex and related white matter, and involve functions such as cognition, vision, emotion, attention, and complex psychological processes.<sup>4</sup> Owing to impairment of sensory and motor function following SCI, brain undergoes functional reorganization, which ultimately helps it in motor function recovery. However, there have been fewer studies describing functional brain reorganization following SCI than those describing structural changes.

The current study by Zheng et al investigates whether brain undergoes extra-sensorimotor functional reorganization following complete thoracolumbar SCI (CTSCI).<sup>5</sup> They also investigate the possible association with particular clinical manifestations and aim to provide targets for transcranial stimulation and gene chip therapy. For that, they utilize resting-state functional MRI (RS-fMRI). They calculate the amplitude of low-frequency fluctuations (ALFF) and, by seed-based approach, investigate the connectivity of functional brain regions for network-level brain changes. Eighteen patients with CTSCI underwent RS-fMRI and ALFF was calculated. Cluster masks were selected per regions of significant between-group differences for performance of functional connectivity (FC) analysis. Correlation analysis was performed between the time series of seeds. Two-sample *t*-test between CTSCI patients and healthy controls was performed with

SPM12. Partial correlation analysis explored the relationships amongst the clinical scores and functional activities and the connectivity in CTSCI patients.

CTSCI patients showed decreased ALFF in the right lingual gyrus (LG), increased ALFF in the right middle frontal gyrus (MFG), and decreased FC between the right LG and Vermis\_3. Subsequent correlation analyses revealed that decreased FC between the right LG and Vermis\_3 positively correlated with the visual analog scale score. As decreased ALFF in LG is associated with depression, it can be deduced that in patients with CTSCI, it may be due to prolonged sensorimotor dysfunction. Increased ALFF in MFG, which plays an important role in sustained attention/vigilance, may be due to its compensatory role to compensate for motor dysfunction in patients with SCI.

The study characterized alterations of regional brain activities and network connectivity at resting state in the CTSCI patients. This study shows functional brain changes in LG, MFG, and cerebellar vermis; regions associated with visual, emotion, and cognition, rather than in sensorimotor cortex. The authors suggest the role of functional training with virtual reality and motor imagery (MI), and stimulation with MI-electroencephalogram in rehabilitation of patients with CTSCI.

The authors did not earlier score the patients for depression and, in hindsight, missed an opportunity. A longitudinal rather than cross-sectional cohort can assess the functional and structural reorganization and its association with the chronicity of the injury. In any future studies, adding visual stimulation of cognition-based training to patient cohort can prove the hypothesis that visual, emotion, and/or cognition-related training can serve as target for sensorimotor functional recovery. Early neuropsychological intervention is also proposed in a recent study to prevent the associated psychological and cognitive dysfunction and irreversible structural brain damage in patients with CTSCI.<sup>6</sup>

The findings suggest a possible theoretical basis of the mechanism of visual, emotion, and/or cognition-related

techniques in rehabilitation training for CTSCI and can help guide future therapies.

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### *References*

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**Level of Evidence: 5**

**Technical Efficacy Stage: 3**