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Editorial

The Impact of Spinal Cord Neuromodulation on Restoration of Walking Ability After Spinal Cord Injury

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There has been growing interest in translational therapies for traumatic spinal cord injury (SCI), and the last several years have witnessed a new era in which discoveries from the laboratory are being translated into man.[1] One of the strategies that has generated considerable excitement is the use of neuromodulatory approaches to activate intact circuits below the level of a severe SCI to activate functional movements, including walking.[2] In the latest issue of *Nature Medicine*, a multinational multidisciplinary team led by Swiss neuroscientist Gregoire Courtine and neurosurgeon Jocelyne Bloch report the restoration of walking in 3 paraplegic individuals using a unique neuromodulatory approach.[3]

The novel aspect of the approach used by Courtine and colleagues was to use spatiotemporal biomimetic stimulation of the dorsal roots,[3] as opposed to placing electrodes over dorsal columns.[4,5] This selectively activated proprioceptive afferents from major locomotor muscles of the legs. The authors designed implantable paddle leads to specifically target the ensemble of dorsal roots of spinal cord segments involved in leg and lower trunk movements. Biomimetic stimulation sequences reproduced natural activation patterns of motor neurons in specific types of motor activities (walking, standing, cycling, sit-to-stand, leg press, and swimming) derived from spatiotemporal maps of motor neuron activation in healthy individuals. The sequences were personalized via a wireless computational framework for the optimal arrangement of stimulation sequences as well as thresholds and guided during neurosurgical positioning. Their software allowed for rapid configuration of activity-specific stimulation programs by the patient with instructors during training sessions that started 10 days after the operation, and weight-supported walking started on the first training day.

The report covers a period of 1 month of training followed by 5 months of neurorehabilitation and is illustrated by videos and other material that are informative and convincing.

The authors optimized stimulation parameters to selectively target proprioceptive afferents, and while this worked, it could not differentiate between afferents from agonist and antagonist muscles that may be running through the same dorsal roots, which may explain some clumsiness of the movements noticeable in the videos.

Of 103 publications before April 2021 on spinal cord stimulation in individuals with SCI (55 epidural, 36 transcutaneous, and 12 magnetic stimulation), 72 used 10 or fewer partici-

pants, and 18 documented at least one adverse event.[2] There is a clear need for larger numbers of participants, extended periods of observation, and attention to adverse events that are known for implanted pad leads.

This exciting technological advance of the Courtine-Bloch team brings new hope to SCI patients. It is part of an ongoing clinical trial, and further cases and observations will hopefully strengthen the evidence to support the use of this technology in individuals with SCI.

Conflict of Interest: The authors have nothing to disclose.

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Title: Evening Sunset Northern California
Artist: Michael G. Fehlings
Year: 2021