

Epidural Spinal Cord Stimulation for Motor-Sensory and Autonomic Function Recovery After Spinal Cord Injury: A Case Series

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Abstract:

Background: Spinal Cord Injury (SCI) refers to damage from traumas such as traffic accidents, falls from heights, gunshots, or non-traumatic diseases such as tumors, bleeding, spina bifida, or degenerations such as tuberculosis and Covid. SCI can lead to significant neurological deficits and lifelong disability and isolation from society; worst of all patients face the risk of early death after a difficult process for both themselves and their loved ones. SCI usually causes permanent loss of motor, sensory, and autonomic functions. The goal of long-standing research is to develop strategies to regenerate axons and restore the function of silent axons.

In recent peer-reviewed studies, spinal cord epidural stimulation (EDS) enabled voluntary movement and restoring of motor-sensory and autonomic functions. The present report describes functional outcomes, surgical and training complication rates, quality of life (QOL) improvements, and patient satisfaction results after EDS. This procedure involves the implantation of a spinal cord stimulator that sends electrical impulses to the spinal cord by jumping. The concept of epidural stimulation dates back to the 1960s, when it was first used to treat chronic pain. But it wasn't until the 1990s that researchers began to explore its potential for treating spinal cord injuries. A groundbreaking study published in the Lancet in 2011 demonstrated the effectiveness of epidural stimulation in restoring voluntary movement in a patient with a chronic spinal cord injury. However, the physiological principles underlying the effect of this intervention remain poorly understood, which has limited the therapeutic approach to continuous stimulation applied to restricted spinal cord locations.

Methods: This article was written to share the results of 50 patients with damage levels between C2-L2 on whom we performed epidural stimulation surgery and stimulator programming treatments between August 2023 and January 2025.

Perioperative complications were recorded as well as long-term complications during training and device related events.

We programmed the stimulators closely resemble the spinal cord's natural firing.

Results: Fifty patients (%74,5 male) SCI underwent EDS using an epidural paddle electrode and internal pulse generator.

37 (74%) were ASIA A, 7 (13%) were ASIA B, and 7 (13%) were ASIA C.

The youngest patient was 7 years old and the oldest one was 54 years old (mean age of 30,1± years)

The longest trauma history was 28 years and the shortest was 3 months.(The interval from SCI to EDS implantation was 5.75± years.)

Each patient's treatment protocol, response to stimulation patterns and progression were different. It was observed that specific factors such as duration of trauma and age did not play a significant role in the speed of recovery.

Each patient's treatment protocol, response to stimulation patterns and progression were in different pattern. It was observed that specific factors such as duration of trauma and age were not significant in the rate of recovery.

Functional improvements were achieved even when the stimulator was off; such as stepping, erection-ejaculation, hot-cold difference sensation.

Conclusion: EDS in this series was safe and achieved numerous benefits on motor, sensory and autonomic regulation. EDS a promising option for improving after motor incomplete or complete SCI. Further studies may quantify these other benefits and clarify EDS's role in SCI patients.

Keywords:

Epidural stimulation, Functional recovery, Neuromodulation, Rehabilitation, Spinal cord injury, Spinal cord stimulation, Spinal surgery, Technical note.