Cervical spinal cord stimulation

- Characteristics of ipsilateral corticomotor pathways in people with cervical Spinal Cord injury
- Electrical spinal cord stimulation promotes focal sensorimotor activation that accelerates brain-computer interface skill learning
- Transcutaneous stimulation of the cervical spinal cord facilitates motoneuron firing and improves hand-motor function after spinal cord injury
- TMS-Indexed neurophysiological signatures of neural compensation in spinal cord injury: associations with injury level, motor function, and affective modulation
- The Neurophysiological Effects of Cervical Transcutaneous Spinal Cord Stimulation With and Without a High Frequency Carrier in Able-Bodied Adults
- Chemogenetic stimulation of phrenic motor output and diaphragm activity
- Pushing the Limits of Interlimb Connectivity: Neuromodulation and Beyond
- Prognostic Value of Minnesota Multiphasic Personality Inventory-2 (MMPI-2) Profiles in Predicting Outcomes of Occipital Nerve Stimulation for Refractory Chronic Migraine: A Retrospective Bias-Corrected Multivariable Analysis

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Cervical Spinal Cord Stimulation: Indications

Cervical Spinal Cord Stimulation (SCS) is primarily used for managing chronic pain and certain neurological conditions.

1. Neuropathic Pain Syndromes

- **Complex Regional Pain Syndrome (CRPS) Type I and II** – Refractory cases affecting the upper extremities.
- **Failed Neck Surgery Syndrome (FNSS)** – Persistent neuropathic pain after cervical spine surgery.
- **Postherpetic Neuralgia** – Chronic pain following herpes zoster infection.
- **Brachial Plexus Injury Pain** – Intractable neuropathic pain despite conservative management.
- **Radicular Pain Syndromes** – Chronic cervical radiculopathy when surgery is not an option.

2. Ischemic Pain Syndromes

- **Refractory Angina Pectoris** – For patients with severe angina not amenable to revascularization (Class IIb indication per ACC/AHA guidelines).
- **Raynaud’s Phenomenon & Vasculopathy** – Severe, refractory cases with digital ischemia.

3. Movement Disorders

- **Cervical Dystonia (Spasmodic Torticollis)** – Emerging use for pain modulation.

- **Parkinson's Disease Tremor and Rigidity** – Experimental cases where deep brain stimulation (DBS) is not feasible.

4. Spinal Cord Injury-Related Conditions

- **Incomplete Spinal Cord Injury (SCI) Pain Syndromes** – Neuropathic pain due to central deafferentation.
- **Post-Stroke Pain Syndrome (Thalamic Pain Syndrome)** – Limited case reports of benefit.

5. Other Emerging Indications

- **Upper Limb Spasticity** – Some evidence of modulation in hypertonic states.
- **Cervical Medullary Syndromes** – In select cases of pain and autonomic dysfunction.

Contraindications

- Active infection at the implant site
- Severe coagulopathy or bleeding disorders
- Psychological conditions contraindicating implantation (e.g., severe depression, somatization)
- Patients with demand-type cardiac pacemakers (relative contraindication)

Cervical spinal cord stimulation (cSCS) is a safe and effective treatment for chronic axial neck pain and upper limb neuropathic pain.

Results suggest that the use of SCS in the cervical spine is a medically effective method of pain management that satisfies and improves the QoL of most patients. The use of SCS can reduce the high cost of direct medical treatment of pain, as well as increase the productivity of patients, and therefore should be reimbursed in appropriately selected patients [1)].

High-cervical spinal cord stimulation can alter cortical activity and cerebral metabolism. These effects are potentially beneficial for disorders of consciousness. A better understanding of the effects of clinical application of stimulation is needed. Piedade et al. aimed to evaluate the existing literature to determine the state of available knowledge. They performed a literature review of clinical studies assessing cervical spinal cord epidural stimulation for disorders of consciousness. Only peer-reviewed articles reporting preoperative and postoperative clinical status were included.

Nineteen studies were included. A total of 532 cases were reported, and 255 patients were considered responsive (47.9%). Considering only studies published after the definition of minimally conscious state (MCS) as an entity, 402 individuals in unresponsive wakefulness syndrome (UWS) and 113 in MCS were reported. Responsiveness to SCS was reported in 170 UWS patients (42.3%) and in 78 MCS cases (69.0%), although the criteria for responsiveness and outcome measures varied among publications.

Cervical spinal cord stimulation yielded encouraging results in patients with disorders of consciousness and seems to be more effective in minimally conscious state. More extensive investigation is needed to understand its potential role in clinical practice [2)]

Case series

Ali et al., from the Department of Neurosurgery, Vanderbilt University Medical Center, Nashville, TN, USA report a novel institutional experience with performing cSCS trials with patients placed in an upright sitting position. This allows easy access to the cervical epidural space and has the added benefit of unobstructed access to the airway.

They retrospectively reviewed data for patients who had undergone cervical spinal cord stimulation trial procedures in an upright, sitting position.

Demographic information including age, gender, preoperative diagnosis, progression to permanent implant after a successful trial and operative time in minutes was collected.

A detailed description of the technique for implantation of cervical spinal cord stimulator trial leads in an upright sitting position is described. A total of 29 patients were implanted; 16 (55%) were female. Mean operative time was 78 minutes from incision to closing. The majority of patients (25/29; 86%) had successful trials and proceeded to permanent implant. No complications occurred and the procedure was well tolerated by all patients.

Cervical spinal cord stimulation trials performed in an upright, sitting position allows for easy epidural access and an unobstructed airway with reasonable set up time [3)].

Wolter and Kieselbach reviewed the records of patients who had been treated at the Interdisciplinary Pain Centre, University Hospital Freiburg, Germany with cervical neurostimulators from November 1, 2001 through October 31, 2011. Information regarding age, gender, diagnosis, age at time of implantation, duration of disease, lead position, hardware in use, revision operations, and stimulation parameters were recorded. In addition, a short telephone interview was conducted, which contained the following items: pain scores on the numeric analog scale (NAS) with and without stimulation, time intervals of stimulation, paresthesia coverage, changes in paresthesia coverage by head movements, unwanted paresthesia of the trunk and legs, treatment satisfaction, and medication intake.

Twenty-three patients were treated. Eighteen patients proceeded to an implantable pulse generator (IPG) implant. In one patient, the system was removed after 4 years despite optimal function, because the patient was no longer experiencing pain. Average NAS pain scores were 6.8 (range 5.5 - 10.0, standard deviation [SD] 1.7) without, and 2.8 (range 0 - 7.5, SD 2.2) with neurostimulation. Fourteen revisions (5 due to lead dislocation, 5 due to lead breakage and 4 IPG revisions) were necessary in 9 of the 18 patients during a mean follow-up of 6.2 years. Most patients reported complete paresthesia coverage. Four patients reported unwanted paresthesia of the trunk or lower limb and 11 patients reported changes in paresthesia with head movements. In both instances, pain reduction was not affected.

LIMITATIONS: Retrospective study.

Cervical spinal cord stimulation appears to be effective in the treatment of neuropathic upper limb

pain. Complications are not significantly more frequent than in SCS for lower limb pain. Changes in paresthesia with head movements and unwanted paresthesia did not affect the outcome [4].

1)
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2)
Piedade GS, Assumpcao de Monaco B, Guest JD, Cordeiro JG. Review of spinal cord stimulation for disorders of consciousness. Curr Opin Neurol. 2023 Oct 27. doi: 10.1097/WCO.0000000000001222. Epub ahead of print. PMID: 37889524.
3)
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