

The Proper Use of Neurostimulation for Hand Pain



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KEYWORDS

- Neuropathic pain • Hand pain • CRPS • Peripheral nerve stimulation • Spinal cord stimulation
- Dorsal root ganglion • Dorsal root ganglion stimulation

KEY POINTS

- Neuropathic pain of the hand can be related to multiple disease processes.
- Neuropathic upper extremity pain disorders include median, radial, and ulnar neuropathy; brachial plexus injuries; complex regional pain syndrome (CRPS) type 1; complex regional pain syndrome type 2 (causalgia); and peripheral neuropathy.
- Neuromodulation is an effective treatment strategy of neuropathic upper extremity pain that has not responded to more conservative measures.
- Neuromodulation therapies include dorsal root ganglion (DRG) spinal stimulation, peripheral nerve stimulation (PNS), and conventional spinal cord stimulation (SCS).
- Physicians should understand when and how to effectively use these therapies.

INTRODUCTION

Upper extremity (UE) neuropathic pain states greatly impact patient functionality and quality of life. Missed workdays associated with complex regional pain syndrome (CRPS) of the UE alone suggest more definitive treatment strategies are necessary.¹ Furthermore, earlier access to advanced pain care therapies may improve outcomes and health care use.²⁻⁴

This article reviews the evidence on the safety and efficacy data for advanced neuromodulation treatment strategies currently available and

surveys future therapies. Therapies covered include spinal cord stimulation (SCS), dorsal root ganglion (DRG) spinal stimulation, and peripheral nerve stimulation (PNS).

Classifications are required for taxonomy purposes. SCS is the placement of electrodes within the neuraxis epidural space with the intent of stimulating the dorsal columns of the spinal cord. DRG spinal stimulation is the placement of leads within the epidural space of the neuraxis with the intent of stimulating the DRG of the spinal cord. PNS is the placement of a lead with the intent of stimulation of peripheral nerves outside of the neuraxis.

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These techniques and targets can treat refractory pain when more conservative therapies are inadequate. The world literature of neurostimulation provides insights on how to select the correct patient, therapy, and disease process for intervention. This international experience suggests future directions for the United States. The international perspective is important because many regulatory bodies outside of the United States allow for human investigation of new devices and subsequent approval much earlier than is achieved in the United States. The implanting or referring doctor should consult with their country of practice regarding approvals and availability of devices.

Cause of Neuropathic Pain of the Upper Extremity

The exact prevalence of neuropathy originating from the periphery is unknown, although it is a contributor in the 8% to 10% of the adults with neuropathic pain.⁵ There are many neuropathic pain states that affect the UE, including peripheral neuropathy; brachial plexus avulsion injuries; compressive neuropathies of the distal UE; median, ulnar, and radial neuropathy; and CRPS type 1 and type 2.^{6,7}

Conservative Treatment Options

Conservative care therapies for UE neuropathic pain syndromes of the hand are focused on the cause of disease. Depending on the type of neuropathic pain, different treatment strategies may be used including physical therapy/occupational therapy, ultrasound (US)-guided injections for diagnostic and therapeutic purposes, surgical intervention, transcutaneous electrical stimulation, nonsteroidal anti-inflammatory drugs, neuropathic pain medications, opioid analgesics, and oral corticosteroids.⁸

NEUROMODULATION OF THE UPPER EXTREMITY

When conservative therapies are inadequate, advanced therapies are used. Neuromodulation techniques have been demonstrated to improve neuropathic pain in the extremity and centrally. These are addressed next in turn.

SPINAL CORD STIMULATION: DORSAL COLUMNS

Background

The clinical use of neurostimulation for the treatment of pain began in the 1960s with the description of the gate-control theory, which posits that nonpainful stimuli can close the "gate" to painful

stimuli.⁹ Shortly thereafter SCS was introduced by Shealy and coworkers in 1967.¹⁰ Over the last 30 years, important insights and advancements have occurred in the use of SCS for the treatment of multiple pain states and for the modulation of neuropathic, vascular, and visceral pathologic states.¹¹ Cervical SCS can be used to treat UE pain.

Mechanism of Action

The exact mechanism of action for the SCS on neuropathic pain is still unknown. Initially, Melzack and Wall⁹ introduced the gate-control theory and proposed that A δ and C fibers were inhibited by the activation of A β .¹² However, other mechanisms may play a significant role, including increasing the dorsal horn inhibitory action of γ -aminobutyric acid, alterations in the activity of wide dynamic range neurons through the orthodromic activation of the primary afferent neurons, activation of the descending inhibitory pain pathways, and modulation of the cholinergic system.^{13–16} Furthermore, SCS induces the release of adenosine, serotonin, and norepinephrine.^{17–20} In addition to modulating neuropathic pain, SCS has also been shown to assist in the treatment of ischemic pain especially when microcirculatory deficiencies exist.^{21–24} Possible mechanisms for SCS to influence peripheral blood flow include (1) modulation of the autonomic nervous system; (2) activation of the descending inhibitory system; and (3) antidromic activation of sensory nerves (A δ and C fibers), and subsequent release of vasodilator mediators including nitric oxide and calcitonin gene-related peptide.^{25–27}

Indications and Patient Selection

Cervical SCS is an effective treatment of neuropathic pain emanating from the neck and UE.^{11,28} Pathologic pain states that may respond include cervical radiculopathy, brachial plexus avulsion injuries, CRPS (type 1 and type 2 causalgia), and peripheral neuropathic pain. Patients are selected for SCS after more conservative therapies have proved to be unsuccessful. These treatments include medication management, minimally invasive interventions (eg, stellate ganglion blocks), and occupational and physical therapy. Unfortunately, less than 50% of patients with neuropathic pain find significant improvement in pain control with any pharmacologic drug.²⁹ Before considering an SCS trial, a patient should undergo a psychological evaluation. Presurgical psychological factors associated with poor outcomes include high levels of somatization, depression, anxiety, and poor coping skills.³⁰ Other

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