Anestezjologia • Ratownictwo • Nauka • Praktyka / Anaesthesiology • Rescue Medicine • Science • Practice

ARTYKUŁ POGLĄDOWY / REVIEW PAPER
Otrzymano/Submitted: 28.05.2025 • Zaakceptowano/Accepted: 07.09.2025

Spinal Cord Stimulation (SCS) as a method of pain treatment – history, present and future

Małgorzata Gola, Jędrzej Sztajura, Maciej Laskowski
Studenckie Koło Naukowe przy Katedrze i Klinice Neurochirurgii Uniwersyteckiego Centrum Klinicznego im. prof. K. Gibińskiego Śląskiego Uniwersytetu Medycznego w Katowicach, Polska

Abstract

Spinal cord stimulation (SCS) is a neuromodulation technique used to manage chronic pain, particularly in cases unresponsive to conventional treatments. First introduced in 1967 and based on the gate control theory of pain, SCS delivers electrical impulses to the spinal cord, reducing pain perception. It is primarily used for failed back surgery syndrome (FBSS) and complex regional pain syndrome (CRPS), but has also shown effectiveness in refractory angina, chronic low back pain, and other conditions. The implantation involves a two-stage process – trial and permanent placement. While generally safe, complications such as lead migration or infection can occur. SCS has proven to be effective and cost-efficient, improving patients' quality of life. Advances in technology are making the therapy more user-friendly. Despite its benefits, further long-term studies are needed to better understand efficacy and reduce risks of therapy failure. *Anestezjologia i Ratownictwo 2025; 19: 231-237. doi:10.53139/AIR.20251924*

Keywords: neurosurgery, spinal cord stimulation, chronic pain, pain management, neuromodulation

Introduction

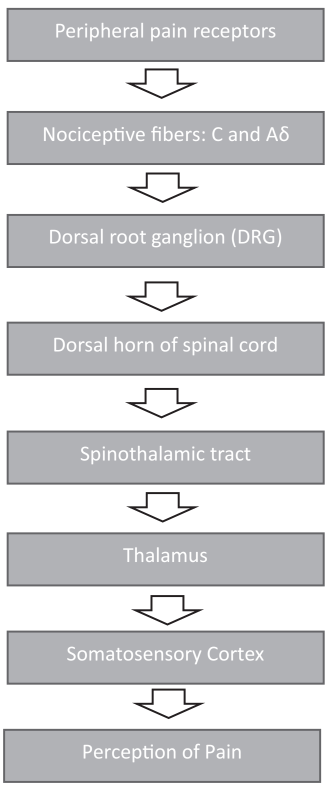
The phenomenon of pain has accompanied humans since the very beginning of their existence and remains one of the fundamental challenges faced by doctors. With the advancement of medicine and technology over the years, new methods of pain management have emerged and continue to be developed, including pharmacological approaches (such as the development of newer, more effective drugs), surgical techniques, and physiotherapy-based methods. One of the few surgical methods of pain treatment involving the direct use of electrical devices is spinal cord stimulator (SCS) therapy. In this paper, the authors described and discussed the characteristics of spinal cord stimulation based on current literature, and also engaged in a discussion on the further development of this method.

History

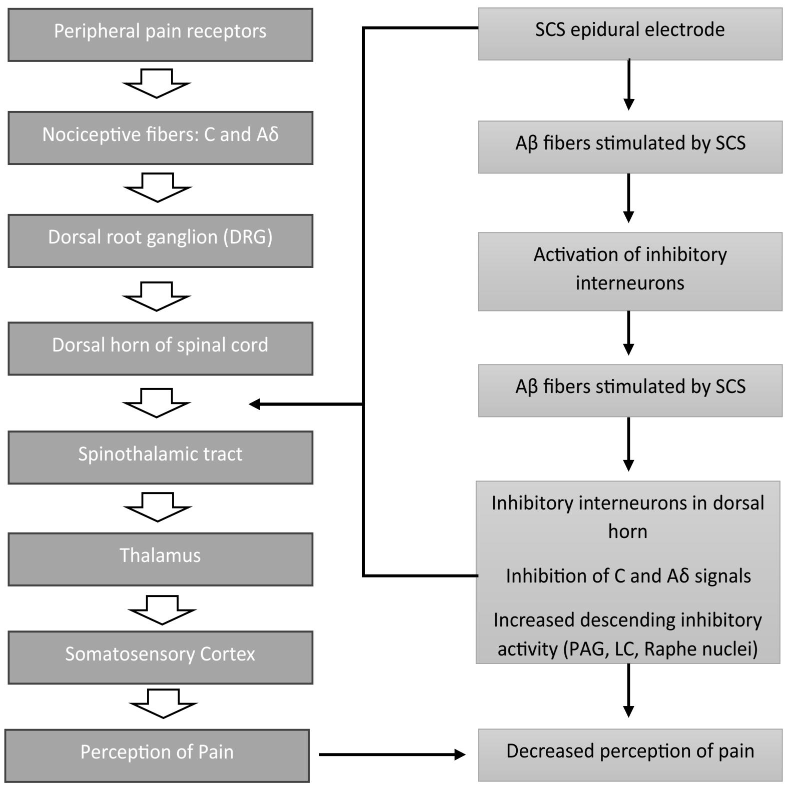
The concept of SCS was first introduced in the 1940s, with the technique being officially implemented in 1967. Its theoretical foundation stems from the gate control theory of pain, proposed by Melzack and Wall in 1965, which revolutionized understanding of pain modulation. SCS works by delivering electrical impulses to the dorsal columns of the spinal cord, preferentially depolarizing large, myelinated Aβ fibers. Activation of these fibers stimulates inhibitory interneurons located in the substantia gelatinosa of the dorsal horn, leading to the suppression of nociceptive signal transmission from small-diameter Aδ and C fibers. The substantia gelatinosa functions as a critical gate control center, modulating the balance between excitatory and inhibitory inputs; when large-diameter Aβ fibers are activated, inhibitory interneurons suppress the transmission of pain signals, effectively "closing the gate" to nociceptive input. This mechanism aligns with the principles of the gate control theory of pain, which posits that the balance between excitatory nociceptive and inhibitory non-nociceptive inputs determines the overall perception of pain. When large-diameter fibers are activated, the "gate" at the level of the dorsal horn closes to nociceptive input, reducing pain transmission to higher centers in the brain. Additionally, SCS may influence the release of neurotransmitters such as GABA, serotonin, and norepinephrine, further modulating pain pathways at both spinal and supraspinal levels. Clinically, this results in a decrease in the intensity of chronic pain and the production of paresthesias in the region corresponding to the affected dermatomes [1-3].

Various stimulation waveforms are employed in SCS, each characterized by unique frequency and amplitude settings that influence pain modulation and the presence or absence of paresthesia. Recent advancements have introduced new waveforms, including burst and high-frequency stimulation, which offer improved efficacy compared to traditional tonic waveforms [4].

The traditional waveform used in this technique, known as tonic stimulation, operates at a steady frequency – typically between 40 and 60 Hz – and with an amplitude sufficient to produce paresthesia. Burst waveforms – including BurstDR™ – have emerged as advanced alternatives to traditional tonic stimulation. Unlike tonic waveforms that deliver constant stimulation at lower frequencies (typically 40–60 Hz), burst waveforms deliver clusters of high-frequency pulses (e.g., intra-burst rates around 500 Hz with bursts occurring at approximately 40 Hz). These bursts mimic natural neuronal firing patterns seen in the brain, particularly in the thalamus, and have been shown to generate both analgesia and reductions in the affective component of pain [5]. Schemes 1. and 2. present the mechanisms of pain transmission and modulation with and without spinal cord stimulation (SCS).



Scheme 1. Physiological pain transmission pathway



Scheme 2. Mechanism of spinal cord stimulation in pain modulation

Indications

SCS is most commonly used when other pain management methods have not provided sufficient relief. Failed back surgery syndrome (FBSS) is the primary reason for using SCS, followed by complex regional pain syndrome (CRPS) as the second most common indication. The literature also describes numerous other applications of SCS, including treatment for refractory angina, peripheral vascular disease, phantom limb pain, lumbar spinal stenosis, post-thoracotomy pain syndrome, chronic head and neck pain, and chronic visceral abdominal pain, among others [6]. Table I. presents the most common indications for SCS implantation.

Table I. Indications for spinal cord stimulation (SCS) implantation

Indication
Failed back surgery syndrome (FBSS)
Complex regional pain syndrome (CRPS)
Peripheral vascular disease and critical limb ischemia
Low back pain (LBP)
Refractory angina pectoris
Parkinson's disease (PD)

FBSS affects approximately 30% of patients who have undergone lumbar spine disc surgery. It is defined by the persistence of chronic pain following surgery, either because the original source of the pain was not adequately treated or because there is an additional, unidentified cause of pain that surgery could not resolve. FBSS can also refer to cases where patients develop new back pain after undergoing spinal surgery [7].

A range of therapeutic strategies is currently employed to manage persistent back and leg pain following spinal surgery. Despite this, SCS is typically introduced later in the treatment process for FBSS. This delayed use is notable given that both Level 1 and 2 evidence supports traditional SCS as a safe, clinically effective, and cost-efficient option [8,9].

CRPS is a long-lasting and disabling nerve-related pain disorder, marked by symptoms involving the autonomic nervous system and inflammation, and it usually develops following a traumatic injury. SCS has proven to be an effective treatment option for individuals with CRPS [10]. Meta-analysis of four randomized controlled trials (RCTs) focusing on low-frequency SCS (LF-SCS) revealed a significant reduction in pain compared to conventional or placebo treatments. In recent years, there has been growing interest in alternative stimulation waveforms, such as burst or high-frequency (HF) SCS. However, RCTs evaluating these nonstandard approaches for CRPS are currently scarce, and long-term data supporting their sustained benefits remain limited. Despite this, some studies suggest that patients may prefer nontraditional SCS modalities, with pain relief outcomes comparable to LF-SCS. Additional research is needed to guide the development of customizable SCS systems that allow patients to select their preferred stimulation type, along with more long-term studies to validate their continued efficacy [11-14].

The use of SCS for treating peripheral vascular disease and critical limb ischemia has shown mixed results in the literature. While case series and case-control studies suggest positive clinical outcomes, including pain relief and improved wound healing, when SCS is combined with standard medical treatments, the overall evidence remains varied [15].

Managing chronic, treatment-resistant low back pain (LBP) remains a difficult task. Traditional conservative and medication-based therapies often provide limited relief. SCS has shown effectiveness in alleviating chronic LBP across different scenarios [16]. Over the past ten years, SCS has seen growing use and demonstrated strong effectiveness in treating chronic LBP that does not respond to conventional care. Numerous high-quality, high-level studies support the application of SCS across different chronic LBP conditions. Studies have shown that SCS not only outperforms comprehensive medical management in providing pain relief but also leads to meaningful improvements in patients' functional abilities and overall quality of life [16-20].

The European Society of Cardiology defines refractory angina pectoris as a long-term condition marked by persistent chest pain due to inadequate blood flow to the heart, occurring in the context of coronary artery disease. This type of angina cannot be effectively managed through a combination of medication, angioplasty, or coronary artery bypass surgery [21]. In 1964, Apthorp et al. reported that 75% of patients experienced significant pain relief after disrupting the sympathetic nervous system. Building on this, Melzack and Wall introduced the "gate control theory" of pain in 1965, suggesting that pain signals are carried through small nociceptive C-fibers in the central nervous system and that their transmission could be modulated. Based on this concept, the first documented use of SCS for treating chronic refractory angina occurred in 1987. In this procedure, an electrode connected to a nerve stimulator was placed in the spinal epidural space to deliver low-amplitude electrical pulses, targeting the spinothalamic tract via dorsal horn interneurons. These impulses inhibited pain signal transmission to the brain, effectively blocking the perception of pain [22-26].

SCS has been explored as a possible treatment approach for alleviating persistent, treatment-resistant symptoms in individuals with Parkinson's disease (PD) [25]. The idea of SCS to improve motor symptoms in PD originated from rodent research, which proposed that stimulating sensory pathways might help interrupt the abnormal low-frequency brain activity commonly observed in PD. Several studies have noted meaningful enhancements in motor performance and overall quality of life as a result [26,27].

Implantation of the stimulator

This procedure can be performed via a percutaneous or open approach [28]. The percutaneous implantation procedure of a spinal cord stimulator (SCS) can be divided into two stages:

Stage I. SCS percutaneous trial. In operating room conditions, electrodes are placed in the appropriate location on the spine in a patient qualified for the procedure. The leads are secured using a suture or surgical adhesive. The electrode is connected to an external pulse generator, which is attached to the patient's body, and the device is programmed. The entire procedure is aimed at assessing the degree of pain relief and clinical improvement in the patient, as well as facilitating the second stage of implantation.

Stage II. Permanent SCS implantation. This stage can be performed just a few days after the trial stimulation. Under local anaesthesia, a skin incision is made. The leads are placed in the supraspinous fascial plane using an anchoring device and sutures. The leads must be positioned in such a way as to avoid bending, which increases the risk of dysfunction. Next, a lateral pocket is created in the lumbar region, where the pulse generator is placed (usually on the side opposite to the one on which the patient most often sleeps or lies). The generator and the leads are connected subcutaneously using an extension wire. The entire procedure takes between one and two hours [29,30].

A pain reduction of at least 50%, increased activity level and/or decreased medication use is considered an effective outcome of SCS therapy [31]. During the postoperative follow-up, it is important to perform imaging (e.g., spinal X-ray) to verify the correct positioning of the generator and leads, and to rule out any displacement.

Complications

The complication rate associated with SCS is relatively high, with reported figures in the literature ranging from 8% to 75%. Complications can arise during surgery, shortly after the procedure, or later in the postoperative period. It is likely that overall complication rates have declined over the past decade due to improvements in technology and surgical techniques. However, reoperations for failed back surgery syndrome still carry a high risk of serious complications, which can result in substantial disability without necessarily relieving pain. Table II. presents the most common complications associated with SCS.

Table II. The most common complications associated with spinal cord stimulation (SCS)

Complications
Electrode migration
Hardware malfunction
Cerebrospinal fluid leakage
Pain at the pulse generator site
Infection
Subcutaneous hematoma
Electrode fracture

Electrode migration or displacement is the most common complication of SCS [6]. It may be indicated by a shift in the area of induced paresthesia, often accompanied by a loss of effective pain relief. The new stimulation zone might fall outside the original pain region or only partially overlap with it. Another potential sign is a change in the voltage needed to produce paresthesia. Lead migration and its direction can typically be confirmed through radiographic imaging, which reveals improper electrode positioning. Even minor shifts may impact the effectiveness of stimulation. Although X-rays sometimes fail to detect clinically significant lead migration, such cases are uncommon. For this reason, capturing an X-ray of the electrode's final position during implantation is useful, as it serves as a baseline for comparison if migration is later suspected [32].

Infection rates for SCS devices reported in the literature vary between 2.5% and 14%, making it one of the most expensive complications associated with the procedure. Certain patients – such as those with diabetes, obesity, a history of smoking, or compromised immune systems – appear to have a higher risk of developing infections. Infections are more frequently observed at the subcutaneous pocket housing the implantable pulse generator (IPG) or at the connector between the extension and the lead, rather than within the spinal canal, where more severe complications like epidural abscesses or meningitis may occur. Similarly, in deep brain stimulation, infections most commonly develop at the IPG site. Fortunately, life-threatening infections are exceedingly rare. The most common microorganism was *Staphylococcus aureus* and *Staphylococcus epidermidis* [33].

The incidence of electrode fracture is approximately 3-9%. An electrode fracture typically leads to a loss of pain relief due to disruption of SCS function. This often presents as a sudden and complete device failure, especially when only a single electrode is in use. In some cases, stimulation may temporarily stop due to battery depletion. Patients might also report a burning sensation. Damage to the insulation can cause electrode malfunction by creating an internal short circuit. While radiography can sometimes identify the site of the break, it is not always reliable. If a fracture is suspected, an impedance test can help confirm the diagnosis elevated impedance is often indicative of a lead break. When confirmed, the damaged lead must be removed and replaced [34].

One of the potential complications during the initial phase of SCS implantation is an inadvertent dural puncture, which can lead to cerebrospinal fluid (CSF) leakage and the development of post-dural puncture headache (PDPH). Although relatively uncommon, the incidence of such dural punctures during percutaneous SCS lead placement has been estimated at approximately 0.48%. PDPH typically presents as a positional headache, often accompanied by nausea, photophobia, and neck stiffness, and is exacerbated by upright posture [35].

Discussion

The neuromodulation technique utilizing SCS has been in clinical use for nearly 60 years [1-3]. During this time, there has been a significant advancement in the technology and an expansion of its applications in the context of pain management.

In this review, we highlight that SCS is utilized across various fields of medicine. It has been successfully employed to provide relief to patients following surgical procedures, as well as in cases of refractory angina pectoris. Its efficacy is supported by the results of studies published to date. SCS is typically employed in cases where conventional pain management strategies have proven ineffective. The leading indication for its use is FBSS, with CRPS being the next most frequent condition treated with this approach. Damián Bendersky and co. highlight the highly effective outcomes of pain treatment in cases of FBSS. Despite the potential for certain complications, SCS is generally considered a safe procedure when conducted correctly and with appropriate patient selection. Moreover, serious or life-threatening adverse events are rare [6].

Elver Ho and co. highlight excellent outcomes in treatment CRPS. SCS has proven to be an effective therapeutic option for patients with CRPS. A meta-analysis of four randomized controlled trials revealed that it significantly reduces pain levels compared to conventional treatments or placebo [10].

In recent years, there has been growing awareness of the use of SCS beyond the field of neurosurgery. A prime example is its application in the treatment of refractory angina pectoris. Since the therapy yields satisfactory results, it can help reduce the number of medications a patient needs to take. This has a positive impact on the patient, not only by lowering the cost of medications but also by minimizing the potential adverse effects associated with polypharmacy [21].

On the other hand, the device may malfunction, posing a risk to the patient and requiring specialized monitoring by both the physician and the manufacturer. At the same time, there is a lack of population-based studies that would allow for the identification of risk factors contributing to the long-term deterioration of SCS efficacy, which could ultimately lead to complete therapy failure.

There is a growing trend toward increased user-friendliness of SCS for patients. Remote calibration or adjustment of the device via the patient's smartphone simplifies its operation and helps save the patient's time. It therefore seems reasonable to assume that the future development of SCS technology will continue to move toward greater accessibility and ease of use [35,37].

ORCID:
M. Gola 0009-0002-4945-7856
J. Sztajura 0009-0009-8975-731X
M. Laskowski 0009-0005-5809-0875

Conflict of interest
None

Correspondence address
Małgorzata Gola
Śląski Uniwersytet Medyczny w Katowicach
ul. Medyków 18, 40-752 Katowice
☎ (+48) 730 215 890
malgorzatagola@hotmail.com

References

1. Wall PD. The role of substantia gelatinosa as a gate control. Res Publ Assoc Res Nerv Ment Dis 1980;58:205-31. doi: 10.1007/978-1-4684-3860-4_13.
2. Mendell LM. Constructing and deconstructing the gate theory of pain. Pain 2014;155:210-6. doi: 10.1016/j.pain.2013.12.010.
3. Katz J, Rosenbloom BN. The golden anniversary of Melzack and Wall's gate control theory of pain: Celebrating 50 years of pain research and management. Pain Res Manag 2015;20:285-6. doi: 10.1155/2015/865487.
4. Wahezi SE, Caparo MA, Malhotra R, et al. Current waveforms in spinal cord stimulation and their impact on the future of neuromodulation: A scoping review. Neuromodulation 2024;27:47-58. doi: 10.1016/j.neurom.2023.11.002.
5. Abbott Education Network. (n.d.). From waveform to stimulation design in spinal cord stimulation [PDF]. Abbott Laboratories.
6. Bendersky D, Yampolsky C. Is Spinal Cord Stimulation Safe? A Review of Its Complications. World Neurosurg 2014;82(6):1359-68. doi: 10.1016/j.wneu.2013.06.012.
7. Kapural L, Peterson E, Provenzano DA, Staats P. Clinical Evidence for Spinal Cord Stimulation for Failed Back Surgery Syndrome (FBSS): Systematic Review. SPINE 2017;42(Suppl):S61-S66. doi: 10.1097/BRS.0000000000002213.
8. Van Buyten J-P, Linderoth B. "The failed back surgery syndrome": Definition and therapeutic algorithms – An update. Eur J Pain Suppl 2010;4(4):273-86. doi: 10.1016/j.eujps.2010.09.006.
9. Kumar K, Taylor RS, Jacques L, et al. Spinal cord stimulation versus conventional medical management for neuropathic pain: a multicentre randomised controlled trial in patients with failed back surgery syndrome. Pain 2007 Nov; 132(1-2): 179-88. doi: 10.1016/j.pain.2007.07.028.
10. Ho E, Yazdanpanah N, Ho J, Drukman B, Chang A, Agarwal S. Parameters of Spinal Cord Stimulation in Complex Regional Pain Syndrome: Systematic Review and Meta-analysis of Randomized Controlled Trials. Pain Physician 2022;25(8):521-30.
11. Canós-Verdecho A, Abejón D, Robledo R, et al. Randomized Prospective Study in Patients With Complex Regional Pain Syndrome of the Upper Limb With High-Frequency Spinal Cord Stimulation (10-kHz) and Low-Frequency Spinal Cord Stimulation. Neuromodulation 2021;24(3):448-58. doi: 10.1111/ner.13358.
12. Kriek N, Groeneweg JG, Stronks DL, de Ridder D, Huygen FJ. Preferred frequencies and waveforms for spinal cord stimulation in patients with complex regional pain syndrome: A multicentre, double-blind, randomized and placebo-controlled crossover trial. Eur J Pain 2017;21(3):507-19. doi: 10.1002/ejp.944.
13. Kemler MA, Reulen JP, Barendse GA, et al. Impact of spinal cord stimulation on sensory characteristics in complex regional pain syndrome type I: a randomized trial. Anesthesiology. 2001;95(1):72-80. doi: 10.1097/00000542-200107000-00016.
14. Sokal P, Malukiewicz A, Kierońska S, et al. Sub-Perception and Supra-Perception Spinal Cord Stimulation in Chronic Pain Syndrome: A Randomized, Semi-Double-Blind, Crossover, Placebo-Controlled Trial. J Clin Med 2020;9(9):2810. doi: 10.3390/jcm9092810.
15. Rock AK, Truong H, Park YL, Pilitsis JG. Spinal Cord Stimulation. Neurosurg Clin N Am 2019;30(2):169-94.
16. Karri J, Orhurhu V, Wahezi S, et al. Comparison of Spinal Cord Stimulation Waveforms for Treating Chronic Low Back Pain: Systematic Review and Meta-Analysis. Pain Physician 2020;23:451-60. ISSN 1533-3159.
17. Kinfe TM, Pintea B, Link C, et al. High Frequency (10 kHz) or Burst Spinal Cord Stimulation in Failed Back Surgery Syndrome Patients With Predominant Back Pain: Preliminary Data From a Prospective Observational Study. Neuromodulation 2016;19(3):268-75. doi: 10.1111/ner.12379.
18. Muhammad S, Roeske S, Chaudhry SR, Kinfe TM. Burst or high-frequency (10 kHz) spinal cord stimulation in failed back surgery syndrome patients with predominant back pain: One year comparative data. Neuromodulation 2017;20:661-7.
19. Deer T, Slavin KV, Amirdelfan K, et al. Success Using Neuromodulation With BURST (SUNBURST) Study: Results From a Prospective, Randomized Controlled Trial Using a Novel Burst Waveform. Neuromodulation 2018;21(1):56-66. doi: 10.1111/ner.12698.
20. Bolash R, Creamer M, Rauck R, et al. Wireless High-Frequency Spinal Cord Stimulation (10 kHz) Compared with Multiwaveform Low-

Frequency Spinal Cord Stimulation in the Management of Chronic Pain in Failed Back Surgery Syndrome Subjects: Preliminary Results of a Multicenter, Prospective Randomized Controlled Study. Pain Med 2019;20(10):1971-9. doi: 10.1093/pm/pnz019.

21. Pan X, Bao H, Si Y, Xu C, et al. Spinal Cord Stimulation for Refractory Angina Pectoris: A Systematic Review and Meta-analysis. Clin J Pain 2017;33(6):543-51. doi: 10.1097/AJP.0000000000000435.
22. Apthorp GH, Chamberlian DA, Hayward GW. The effect of sympathectomy on the electrocardiogram and effort tolerance in angina pectoris. Br Heart J 1964;26:218-26.
23. Melzack R, Wall PD. Pain mechanisms: a new theory. Science 1965;150:971-9.
24. Murphy DF, Giles KE. Dorsal column stimulation for pain relief from intractable angina pectoris. Pain 1987;28:365-8.
25. Sarica C, Zemmar A, Yousefi O, et al. Spinal Cord Stimulation for Parkinson's Disease: A Systematic Review and Meta-Analysis of Pain and Motor Outcomes. Stereotact Funct Neurosurg 2023;101(4):244-53. doi: 10.1159/000531089.
26. Hubsch C, D'Hardemare V, Ben Maacha M, et al. Tonic spinal cord stimulation as therapeutic option in Parkinson disease with axial symptoms: Effects on walking and quality of life. Parkinsonism Relat Disord 2019;63:235-7. doi: 10.1016/j.parkreldis.2019.02.044.
27. Pinto de Souza C, Hamani C, et al. Spinal cord stimulation improves gait in patients with Parkinson's disease previously treated with deep brain stimulation. Mov Disord 2017; 32(2):278-82. doi: 10.1002/mds.26850.
28. Beletsky A, Liu C, Vickery K, et al. Spinal cord stimulator (SCS) placement: Examining outcomes between the open and percutaneous approach. *Neuromodulation* 2023;26:1067-73. doi: 10.1016/j.neurom.2022.11.010.
29. Garcia K, Wray JK, Kumar S. Spinal Cord Stimulation. [Updated 2023 Apr 24]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2025.
30. Malige A, Sokunbi G. Spinal Cord Stimulators: A Comparison of the Trial Period Versus Permanent Outcomes. Spine (Phila Pa 1976). 2019;44(11):E687-E692. doi: 10.1097/BRS.0000000000002921.
31. Simopoulos T, Sharma S, Aner M, Gill JS. A Temporary vs. Permanent Anchored Percutaneous Lead Trial of Spinal Cord Stimulation: A Comparison of Patient Outcomes and Adverse Events. Neuromodulation 2018;21(5):508-12. doi: 10.1111/ner.12687.
32. Cameron T. Safety and efficacy of spinal cord stimulation for the treatment of chronic pain: a 20-year literature review. J Neurosurg 2004;100(3 Suppl Spine):254-67. doi: 10.3171/spi.2004.100.3.0254.
33. Atkinson L, Sundaraj SR, Brooker C, et al. Recommendations for patient selection in spinal cord stimulation. J Clin Neurosci. 2011;18(10):1295-302. doi: 10.1016/j.jocn.2011.02.025. Epub 2011 Jun 29. PMID: 21719293.
34. Barolat G. Spinal cord stimulation for chronic pain management. Arch Med Res 2000;31(3):258-62. doi: 10.1016/s0188-4409(00)00075-8.
35. Stotts R, Jain R, DO AA, Al-Jumah R. Management of post dural puncture headache during spinal cord stimulation trials: A review of current literature. Curr Pain Headache Rep 2024;28:1073-8. doi: 10.1007/s11916-024-01289-5.
36. Lorach H, Galvez A, Spagnolo V, et al. Walking naturally after spinal cord injury using a brain–spine interface. Nature 2023;618:126-33. doi: 10.1038/s41586-023-06094-5.
37. Staats P, Deer TR, Hunter C, et al. Remote Management of Spinal Cord Stimulation Devices for Chronic Pain: Expert Recommendations on Best Practices for Proper Utilization and Future Considerations. Neuromodulation 2023; 26(7):1295-308. doi: 10.1016/j.neurom.2023.07.003.