Osmangazi Journal of Med, 2025;47(6):923-930
DOI: 10.20515/otd.1718154

Research Article
Araştırma Makalesi

Osmangazi Journal of Medicine
e-ISSN: 2587-1579

Retrospective Analysis of Spinal Cord Stimulation: 15-Year Single-Center Experience

Spinal Kord Stimulasyonunun Retrospektif Analizi: 15 Yıllık Tek Merkez Deneyimi

[1]Ümit Akkemik, [1]Sinan Oğuzhan Ulukaya, [2]Tuba Tanyel Saraçoğlu, [1]Mehmet Sacit Güleç, [1]Ayten Bilir

[1]Department of Algology, Eskişehir Osmangazi University Faculty of Medicine, Eskişehir, Türkiye
[2]Department of Algology, Başakşehir Çam and Sakura City Hospital, Istanbul, Türkiye

ORCID ID of the authors
ÜA. 0000-0001-8483-5416
SOU. 0000-0002-4217-6114
TTS. 0000-0002-0502-3389
MSG. 0000-0002-7107-3798
AB. 0000-0002-3491-3209

Correspondence / Sorumlu yazar:
Ümit AKKEMİK

Eskişehir Osmangazi University, Faculty of Medicine, Department of Algology, Eskişehir, Türkiye

e-mail: umit.akkemik@ogu.edu.tr

Abstract: Spinal cord stimulation (SCS) is an established neuromodulation technique for chronic pain management. This study evaluated outcomes and complications of SCS therapy across various chronic pain conditions. This retrospective, single-center cohort study analyzed 61 patients who received SCS implantation between January 2008 and December 2023. Treatment effectiveness was defined as a >50% reduction in Numeric Rating Scale (NRS) scores. Patient satisfaction was assessed using a 5-point Likert scale. Secondary outcomes included complications, revision requirements, and device longevity. Failed Back Surgery Syndrome (FBSS) was the most common indication (73.8%), followed by peripheral vascular disease (PVD) (8.2%). Overall treatment effectiveness was achieved in 90.2% of patients, with 100% success rates for complex regional pain syndrome (CRPS), PVD, phantom pain, peripheral nerve damage, spinal tumor, and stroke-related neuropathic pain. Among FBSS patients, 86.7% achieved significant pain reduction. Patient satisfaction was high, with 82.0% reporting positive satisfaction (67.2% very satisfied, 14.8% partially satisfied). Revision surgery was required in 16.4% of cases, treatment termination occurred in 8.2%, and implantable pulse generator replacement was necessary in 18.0%. Treatment failure rate was only 3.3%. SCS demonstrated high treatment effectiveness and patient satisfaction across various chronic pain conditions. The favorable safety profile with low treatment failure rates supports SCS as an important component of comprehensive pain management strategies when applied with appropriate patient selection criteria.
Keywords: Spinal cord stimulation, Chronic pain management, Neuromodulation

Özet: Spinal kord stimülasyonu (SKS), kronik ağrı yönetimi için belirlenmiş bir nöromodülasyon tekniğidir. Bu çalışma, çeşitli kronik ağrı durumlarında SKS tedavisinin sonuçlarını ve komplikasyonlarını değerlendirmektedir. Bu retrospektif, tek merkezli kohort çalışmasında, Ocak 2008 ile Aralık 2023 arasında SKS implantasyonu uygulanan 61 hasta analiz edildi. Başarılı tedavi, Sayısal Derecelendirme Ölçeği (SDÖ) puanlarında >%50 azalma olarak tanımlandı. Hasta memnuniyeti 5 puanlı Likert ölçeği kullanılarak değerlendirildi. İkincil sonuçlar arasında komplikasyonlar, revizyon gereksinimleri ve cihazın uzun ömürlülüğü yer aldı. Başarısız Sırt Cerrahisi Sendromu (BBCS) en yaygın endikasyondu (%73,8), bunu periferik vasküler hastalık (PVH) (%8,2) izledi. Genel tedavi etkinliği hastaların %90,2'sinde elde edildi ve kompleks bölgesel ağrı sendromu (KBAS), PVH, fantom ağrısı, periferik sinir hasarı, spinal tümör ve felçle ilişkili nöropatik ağrı için %100 başarı oranları elde edildi. BBCS hastaları arasında %86,7'si önemli ağrı azalması elde etti. Hasta memnuniyeti yüksekti, %82.0'ı olumlu memnuniyet bildirdi (%67.2 çok memnun, %14.8 kısmen memnun). Vakaların %16.4'ünde SKS revizyonu gerekti, %8.2'sinde tedavi sonlandırıldı ve %18.0'inde implante edilebilir puls jeneratörü değişimi gerekti. Tedavi başarısızlık oranı sadece %3.3'tü. SKS, çeşitli kronik ağrı durumlarında yüksek tedavi etkinliği ve hasta memnuniyeti gösterdi. Düşük tedavi başarısızlık oranlarına sahip olumlu güvenlik profili, uygun hasta seçimi kriterleriyle uygulandığında SKS'yi kapsamlı ağrı yönetimi stratejilerinin önemli bir bileşeni olarak desteklemektedir.
Anahtar Kelimeler: Spinal kord stimulasyonu, Kronik ağrı tedavisi, Nöromodülasyon

Ethics Committee Approval: The study was approved by Eskişehir Osmangazi University Noninterventional Clinical Research Ethical Committee (Decision no: 144, Date: 29.04.2025)
Informed Consent: The authors declared that it was not considered necessary to get consent from the patients because the study was a retrospective data analysis.
Authorship Contributions: Study Conception/Design: ÜA, SOU, TTS, MSG, AB Data Collection: ÜA, SOU, TTS, MSG, AB Data Analysis/Interpretation: ÜA, TTS, AB Drafting of Manuscript: ÜA, SOU, TTS, MSG, AB Critical Review of Content: AB, MSG Final Approval and Responsibility: ÜA, SOU, TTS, MSG, AB Material and Technical Support: ÜA, AB Supervision: MSG, AB
Copyright Transfer Form: Copyright Transfer Formwas signed by all authors.
Conflict of Interest: The authors declare that they have no competing interests.
Financial Disclosure: The authors received no financial support for the research, authorship, and/or publication of this article.

Received : 12.06.2025
Accepted :.21.08.2025
Published : 01.09.2025

How to cite/ Atıf için: Akkemik ü, Ulukaya SO , Saraçoğlu TT, Güleç MS , Bilir A, Retrospective Analysis of Spinal Cord Stimulation: 15-Year Single-Center Experience, Osmangazi Journal of Medicine, 2025;47(6):923-930

1. Introduction

Spinal Cord Stimulation (SCS) is a well-established, minimally invasive neuromodulation technique that has emerged as an effective therapeutic option for chronic pain management in recent years (1). Evidence from randomized controlled trials has demonstrated the efficacy of SCS for specific neuropathic pain conditions, including failed back surgery syndrome (FBSS), complex regional pain syndrome (CRPS), peripheral vascular disease (2,3,4,5). The Neuromodulation Appropriateness Consensus Committee has established clear guidelines supporting SCS for these established indications, with studies consistently showing significant pain reduction and improved quality of life (6).

Modern SCS systems incorporate advanced technology including rechargeable pulse generators, multiple independent current control, and various stimulation waveforms. Despite technological advances, complication rates of 30-40% have been reported, including hardware-related issues such as lead migration, infection, and stimulation-related problems (7). Long-term studies reveal that while many patients experience initial success, outcomes may vary over time, with some requiring device revision or experiencing diminishing effects (8,9).

Real-world outcome data from registries provide valuable insights beyond controlled trials, demonstrating clinically meaningful pain relief and quality of life improvements for most patients, with satisfaction rates typically exceeding 70% at long-term follow-up (10). However, recent systematic reviews have raised questions about long-term efficacy, underscoring the importance of comprehensive follow-up studies (11,12).

Single-center experiences offer important perspectives on real-world outcomes, patient selection strategies, and management approaches that complement findings from large multicenter studies. Understanding institutional practices and patient outcomes across different settings is essential for optimizing treatment protocols and improving patient care. The present study evaluates our institutional experience with SCS to provide insights into treatment outcomes and contributes to the broader understanding of this therapeutic modality.

2. Materials and Methods

This retrospective, single-center cohort study examined medical records of all patients who received SCS implantation at our tertiary care center during a 15-year period from January 2008 to December 2023. The institutional ethics committee approved this study (Ethics Approval No: [144], Date: [29.4.2025]), and all procedures followed the Declaration of Helsinki and relevant ethical guidelines. Given the retrospective design, informed consent was waived while maintaining strict patient confidentiality and data anonymization throughout the research.

a. Patient Selection

Inclusion criteria comprised: (1) age 18 years or older; (2) SCS implantation during the study period; (3) minimum 12-month follow-up; and (4) complete medical records. Patients lacking 12-month post-implantation follow-up data were excluded.

b. Measurements

Patient demographics, medical history, and baseline pain characteristics were extracted from electronic medical records. Pain intensity was assessed using the 11-point Numeric Rating Scale (NRS), ranging from 0 (no pain) to 10 (worst imaginable pain). NRS scores recorded during pre-implantation evaluation and at regular post-implantation intervals were retrieved from patient files.

The primary outcome was treatment effectiveness, defined as greater than 50% reduction in NRS scores from baseline to final follow-up. This threshold represents clinically meaningful improvement and serves as an established benchmark for successful SCS therapy.

Patient satisfaction was assessed using a 5-point Likert scale questionnaire during routine follow-up visits, with categories ranging from completely dissatisfied to quite satisfied. Patients rated their overall treatment satisfaction considering pain relief, functional improvement, quality of life, and adverse effects.

Secondary outcomes included treatment-related complications (device-related, procedure-related, and therapy-related), revision surgery requirements, and treatment termination rates with associated reasons. Device longevity was evaluated by monitoring implantable pulse generator battery life and replacement needs. Lead-related complications such as migration, fracture, or impedance changes were documented. Changes in analgesic medication

consumption were tracked to assess potential medication reduction following SCS implantation.

c. Statistical Methods

The distributional characteristics of continuous variables were assessed using the Shapiro–Wilk test to evaluate normality. For non-normally distributed paired data, the nonparametric Wilcoxon signed-rank test was used. Differences in proportions were tested using exact binomial tests, with 95% confidence intervals and exact p-values reported. Associations between categorical variables were analyzed using the chi-square test, and when assumptions for the chi-square test were not met, exact p-values were calculated using the exact test method. Post hoc power analyses for one-sample proportion tests were performed using PASS 11 software. These analyses showed that the sample size achieved of 61 provided 100% power to detect differences of 0.8197 and 0.9016 from null hypotheses of 0.25 and 0.50, respectively, under a two-sided exact test with a significance level of 0.05. A p-value of <0.05 was considered statistically significant. All statistical analyses were conducted using IBM SPSS Statistics Version 27.

3. Results

a. Patient Demographics and Indications

This study analyzed data from 61 patients with a relatively balanced gender distribution, comprising 33 females (54.1%) and 28 males (45.9%). Patient ages ranged from 18 to 80 years, with a mean age of 53.0 years (SD = 14.1). The demographic characteristics of the patient cohort indicate a predominantly middle-aged population with moderate age variability across the sample. The most common indication for SCS therapy was FBSS, accounting for 73.8% (n=45) of cases. Other indications included PVD in 8.2% (n=5), CRPS, phantom pain, and peripheral nerve damage, each representing 4.9% (n=3) of cases. Spinal tumor and stroke-related neuropathic pain were the least common indications, each accounting for 1.6% (n=1) of cases (Table 1).

b. Treatment Complications and Device-Related Issues

The majority of patients (83.6%, n=51) did not require revision surgery due to complications, while 16.4% (n=10) underwent revision procedures. The revision procedure was performed in 3 patients due to lead migration and in one patient due to local infection in the IPG region. Treatment termination due to complications occurred in 8.2% (n=5) of patients. The complication that caused termination in all these patients was infection. Implantable pulse generator (IPG) replacement was necessary in 18.0% (n=11) of patients. Treatment failure occurred in only 3.3% (n=2) of patients (Table 2).

Overall treatment effectiveness, defined as >50% reduction in NRS scores and treatment termination, was achieved in 90.2% (n=55) of patients. When analyzed by indication, treatment effectiveness varied across different conditions. All patients with CRPS (100%, n=3), PVD (100%, n=5), phantom pain (100%, n=3), peripheral nerve damage (100%, n=3), spinal tumor (100%, n=1), and stroke-related neuropathic pain (100%, n=1) achieved >50% pain reduction. Among FBSS patients, 86.7% (n=39) achieved significant pain reduction, while 13.3% (n=6) did not reach the 50% threshold (Table 3).

c. Patient Satisfaction

Patient satisfaction levels were generally high across all indications (Table 4). Overall, 67.2% (n=41) of patients reported being "quite satisfied" with their treatment, while 14.8% (n=9) were "partially satisfied." Negative satisfaction responses were less common, with 6.6% (n=4) reporting partial dissatisfaction, 6.6% (n=4) expressing complete dissatisfaction, and 4.9% (n=3) remaining neutral.

Satisfaction levels varied by indication (Table 5). Among FBSS patients, 68.9% (n=31) were quite satisfied, 11.1% (n=5) were partially satisfied, while 8.9% (n=4) were not satisfied at all, 6.7% (n=3) were partially dissatisfied, and 4.4% (n=2) remained neutral. All patients with phantom pain (100%, n=3) and stroke-related neuropathic pain (100%, n=1) reported being quite satisfied. Among CRPS patients, 66.7% (n=2) were quite satisfied and 33.3% (n=1) were partially satisfied.

d. Association Between SCS Indication and Treatment Effectiveness

Chi-square analysis revealed no statistically significant association between SCS indication and treatment effectiveness ($\chi^2 = 2.366$, df = 6, p = 0.883). The Fisher-Freeman-Halton exact test confirmed this finding (p = 1.000). However, it should be noted that 92.9% of cells had expected counts less than 5, limiting the reliability of the chi-square test results.

e. Association Between SCS Indication and Patient Satisfaction

Statistical analysis using chi-square test showed no significant association between SCS indication and patient satisfaction levels ($\chi^2 = 25.184$, df = 24, p = 0.396). The Fisher-Freeman-Halton exact test supported this finding (p = 0.523). However, like the effectiveness analysis, 94.3% of cells had expected counts less than 5, which may affect the reliability of these statistical comparisons.

The complete statistical analysis results for both treatment effectiveness and patient satisfaction according to indication are summarized in Table 6. A comprehensive summary of all treatment outcomes is provided in Table 7.

Table 1. Distribution of SCS Indications

Indication	Patient Count	Percentage (%)
FBSS	45	73.8
PVD	5	8.2
CRPS	3	4.9
Phantom Pain	3	4.9
Peripheral Nerve Damage	3	4.9
Spinal Tumor	1	1.6
Stroke-related Neuropathic Pain	1	1.6
TOTAL	**61**	**100.0**

FBSS: Failed Back Surgery Syndrome, PVD: Peripheral Vascular Disease, CRPS: Complex Regional Pain Syndrome

Table 2. Complications and Revisions

Causes	No	No (%)	Yes	Yes (%)
Revision Due to Complication	51	83.6	10	16.4
Termination Due to Complication	56	91.8	5	8.2
IPG Replacement	50	82.0	11	18.0
Treatment Failure	59	96.7	2	3.3

IPG: Implantable pulse generator

Table 3. Treatment Effectiveness (≥50% NRS Improvement)

Indication	Successful Treatment	Success Rate (%)	Failed Treatment	Failure Rate (%)
CRPS	3	100.0	0	0.0
FBSS	39	86.7	6	13.3
PVD	5	100.0	0	0.0
Phantom Pain	3	100.0	0	0.0

Indication	Successful Treatment	Success Rate (%)	Failed Treatment	Failure Rate (%)
Peripheral Nerve Damage	3	100.0	0	0.0
Spinal Tumor	1	100.0	0	0.0
Stroke-related Neuropathic Pain	1	100.0	0	0.0
TOTAL	**55**	**90.2**	**6**	**9.8**

FBSS: Failed Back Surgery Syndrome, PVD: Peripheral Vascular Disease (PVD), CRPS: Complex Regional Pain Syndrome

Table 4. Overall Patient Satisfaction Distribution

Satisfaction Level	Patient Count	Percentage (%)
Very Satisfied	41	67.2
Partially Satisfied	9	14.8
Neutral	3	4.9
Partially Dissatisfied	4	6.6
Very Dissatisfied	4	6.6
TOTAL	**61**	**100.0**

Table 5. Satisfaction Distribution

Indication	Very Satisfied	Partially Satisfied	Neutral	Partially Dissatisfied	Very Dissatisfied	Total
CRPS	2 (66.7%)	1 (33.3%)	0 (0%)	0 (0%)	0 (0%)	3
FBSS	31 (68.9%)	5 (11.1%)	2 (4.4%)	3 (6.7%)	4 (8.9%)	45
PVD	2 (40.0%)	2 (40.0%)	1 (20.0%)	0 (0%)	0 (0%)	5
Phantom Pain	3 (100%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	3
Peripheral Nerve Damage	2 (66.7%)	1 (33.3%)	0 (0%)	0 (0%)	0 (0%)	3
Spinal Tumor	0 (0%)	0 (0%)	0 (0%)	1 (100%)	0 (0%)	1
Stroke-related Neuropathic Pain	1 (100%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1

FBSS: Failed Back Surgery Syndrome, PVD: Peripheral Vascular Disease, CRPS: Complex Regional Pain Syndrome

Table 6. Statistical Analysis Results of Treatment Effectiveness and Patient Satisfaction According to Indication

Analysis	Test Type	Chi-Square Value	p-value	Significance
Treatment Efficacy vs. Indication	Pearson Chi-Square	2.366	0.883	Not Significant
Treatment Efficacy vs. Indication	Fisher's Exact Test	2.746	1.000	Not Significant
Satisfaction vs. Indication	Pearson Chi-Square	25.184	0.396	Not Significant
Satisfaction vs. Indication	Fisher's Exact Test	25.272	0.523	Not Significant

Table 7. Spinal Cord Stimulation Treatment Outcomes Summary

Metric	Value
Total Patient Count	61
Overall Treatment Success Rate	90.2%
Positive Satisfaction Rate (Very + Partially Satisfied)	82.0%
Revision Rate Due to Complication	16.4%
Termination Rate Due to Complication	8.2%
IPG Replacement Rate	18.0%
Treatment Failure Rate	3.3%

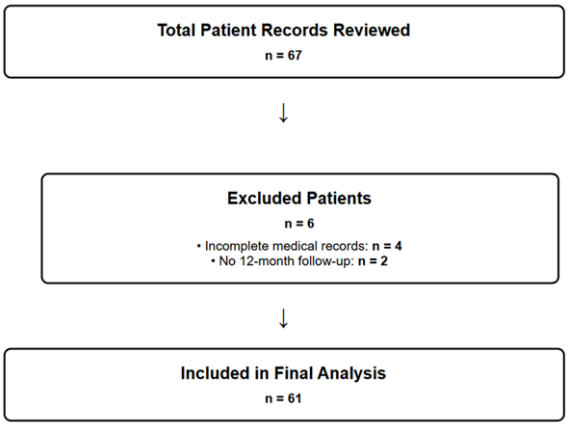

Figure 1. Patient Selection Flowchart

4. Discussion

This retrospective analysis of 61 patients treated with SCS provided valuable insights into the real-world outcomes and complications associated with this neuromodulation therapy across various chronic pain conditions. Our findings demonstrated generally favorable outcomes with high treatment effectiveness and patient satisfaction rates, while highlighting important considerations regarding device-related complications and the need for revision procedures.

Our study demonstrated an overall treatment effectiveness rate of 90.2%, defined as >50% reduction in NRS scores, which aligns with and potentially exceeds rates reported in several large-scale registry studies. This finding is particularly encouraging when compared to the 50.3% success rate (NRS pain score ≤3) reported in a European multicenter study of 171 single-stage SCS patients (13). Similarly, our results are consistent with the UK and Ireland National Neuromodulation Registry data, which showed that 75.3% of 1,236 patients demonstrated improvement in quality-of-life measures following SCS therapy (10).

The variation in effectiveness across different pain conditions observed in our cohort reflects the established understanding that SCS efficacy is highly dependent on patient selection and indication. Notably, all patients with CRPS, peripheral vascular disease, phantom pain, and peripheral nerve damage achieved >50% pain reduction, supporting the well-established role of SCS in these conditions. Among patients with FBSS, 86.7% achieved significant pain reduction, which compares favorably with the findings from Kurt et al.'s integrative review, where SCS showed beneficial effects across different domains of life in FBSS patients (14).

Our complication profile reveals important insights into the safety of contemporary SCS therapy. The revision surgery rate of 16.4% in our cohort is notably lower than historical reports, which documented revision rates of up to 30-40% with older-generation devices (15). This improvement likely reflects advances in device technology, surgical techniques, and patient selection criteria that have evolved over the past decade.

The device explantation rate due to treatment failure (3.3%) is substantially lower than the 7.6% overall explantation rate reported in the large RELIEF registry study of 1,289 patients, where 2.5% of patients underwent explantation specifically due to inadequate pain relief (16). This comparison suggests that our patient cohort may have benefited from refined patient selection criteria or represent a population with particularly favorable characteristics for SCS.

The IPG replacement rate of 18.0% in our study falls within the expected range for battery depletion and device longevity issues. This IPG replacement rate aligns well with the real-world evidence from Deer et al.'s large-scale Medicare analysis, which reported replacement rates of 33.7% for primary cell and 29.5% for rechargeable devices at seven years post-implantation (17). However, this comparison must be interpreted within the context of different follow-up periods and patient populations. While Deer et al.'s study captured long-term replacement patterns over a seven-year period in a Medicare population with extended follow-up, our 18.0% replacement rate likely represents a shorter-term observation period, making it consistent with the expected trajectory of device replacements over time. The progressive increase in replacement rates observed in the Medicare study - from initial low rates in the first year to nearly one-third of devices by seven years - suggests that our 18.0% rate represents an intermediate timepoint in the natural history of SCS device longevity. This finding supports our assertion that the replacement rate falls within the expected range for battery depletion and device longevity issues. Replacement procedures are typically planned interventions for battery end-of-life rather than unexpected complications. Patients who undergo replacement generally continue to benefit from SCS therapy, as demonstrated by their willingness to undergo repeat procedure.

Our study's patient satisfaction rate of 82.0% (67.2% quite satisfied, 14.8% partially satisfied) closely aligns with Hagedorn et al.'s systematic review and meta-analysis of 32 studies (n=1,355), which reported a pooled satisfaction rate of 82.2% (95% CI, 77.8%–86.2%) for SCS and dorsal root ganglion stimulation across various chronic pain conditions (18). This remarkable consistency across diverse patient populations—including FBSS, CRPS, and painful diabetic neuropathy—validates our findings and demonstrates the reproducible efficacy of neuromodulation therapies. The correlation between treatment effectiveness and patient satisfaction across different indications suggests that objective pain reduction translates meaningfully into subjective patient experience, supporting a comprehensive SCS evaluation approach that incorporates both quantitative pain measures and patient-reported outcomes.

Our findings support the continued evolution of SCS as a viable treatment option for carefully selected patients with chronic pain conditions. The absence of statistically significant associations between indication type and either treatment effectiveness or patient satisfaction may reflect the importance of individual patient factors beyond diagnosis in determining SCS outcomes.

This study has several limitations. The retrospective design and relatively small sample size limit the generalizability of findings, particularly for rare

indications. Non-standardized follow-up intervals and outcome measurement tools may have introduced variability in treatment success assessment. Small subgroup sizes, especially for rare indications, severely limit the capacity for statistical analysis, and the results may not be generalizable to other institutions with different protocols or patient populations. Future prospective studies with larger patient cohorts and standardized outcome measures would strengthen the evidence base for SCS across different pain conditions.

In conclusion, this real-world analysis demonstrates that SCS can provide effective pain relief and high patient satisfaction across various chronic pain conditions when applied with appropriate patient selection. The favorable safety and low treatment failure rates support SCS as an important component of comprehensive pain management strategies.

REFERENCES

1. Sdrulla AD, Guan Y, Raja SN. Spinal Cord Stimulation: Clinical Efficacy and Potential Mechanisms. Pain Pract. 2018 Nov;18(8):1048-1067. doi: 10.1111/papr.12692. Epub 2018 Apr 23. PMID: 29526043; PMCID: PMC6391880.
2. Kumar K, Taylor RS, Jacques L, Eldabe S, Meglio M, Molet J, Thomson S, O'Callaghan J, Eisenberg E, Milbouw G, Buchser E. 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 1;132(1-2):179-88.
3. Mattie R, Lin AB, Bhandal H, Gill B, Tram J, Braun S, Prabakar N, Yin CT, Brar N, Fox A, Saltychev M. Spinal cord stimulation for the treatment of complex regional pain syndrome: A systematic review of randomized controlled trials. Interventional Pain Medicine. 2024 Dec 1;3(4):100527.
4. Asimakidou E, Matis GK. Spinal cord stimulation in the treatment of peripheral vascular disease: a systematic review–revival of a promising therapeutic option?. British Journal of Neurosurgery. 2022 Sep 3;36(5):555-63.
5. Jaffee S, Verma R, Vaezi M, Kite T, Tomycz N. A scoping review of spinal cord stimulation for phantom limb pain. Interventional Pain Medicine. 2025 Mar 1;4(1):100571.
6. Deer TR, Russo M, Grider JS, Sayed D, Lamer TJ, Dickerson DM et al. The neurostimulation appropriateness consensus committee (NACC)®: recommendations for spinal cord stimulation long-term outcome optimization and salvage therapy. Neuromodulation: Technology at the Neural Interface. 2024 Jun 19.
7. Eldabe S, Buchser E, Duarte RV. Complications of spinal cord stimulation and peripheral nerve stimulation techniques: a review of the literature. Pain Med. 2016;17(2):325-336.
8. Thomson SJ, Kruglov D, Duarte RV. A spinal cord stimulation service review from a single centre using a single manufacturer over a 7.5 year follow-up period. Neuromodulation. 2017;20(6):589-599.
9. Brill S, Defrin R, Aryeh IG, Zusman AM, Benyamini Y. Short-and long-term effects of conventional spinal cord stimulation on chronic pain and health perceptions: A longitudinal controlled trial. European Journal of Pain. 2022 Oct;26(9):1849-62.
10. Martin SC, Baranidharan G, Thomson S, et al. Spinal cord stimulation improves quality of life for patients with chronic pain—data from the UK and Ireland National Neuromodulation Registry. Neuromodulation. 2024;27(8):1406-1418.
11. O'Connell NE, Ferraro MC, Gibson W, et al. Implanted spinal neuromodulation interventions for chronic pain in adults. Cochrane Database Syst Rev. 2021;12:CD013756.
12. Traeger AC, Gilbert SE, Harris IA, Maher CG. Spinal cord stimulation for low back pain. Cochrane Database Syst Rev. 2023;3:CD014789.
13. De Negri P, Paz-Solis JF, Rigoard P, Raoul S, Kallewaard JW, Gulve A, Thomson S, Canós-Verdecho MA, Love-Jones S, Williams A, Rascón-Ramírez FJ. Real-world outcomes of single-stage spinal cord stimulation in chronic pain patients: A multicentre, European case series. Interventional Pain Medicine. 2023 Sep 1;2(3):100263.
14. Kurt E, Noordhof RK, van Dongen R, Vissers K, Henssen D, Engels Y. Spinal Cord Stimulation in Failed Back Surgery Syndrome: An Integrative Review of Quantitative and Qualitative Studies. Neuromodulation. 2022;25:657-670.
15. Rosenow JM, Stanton-Hicks M, Rezai AR, Henderson JM. Failure modes of spinal cord stimulation hardware. Journal of Neurosurgery: Spine. 2006;5:183-190.
16. Rauck RL, Loudermilk E, Thomson SJ, Paz-Solis JF, Bojrab L, Noles J, Vesper J, Atallah J, Roth D, Hegarty J, Prud'Homme M. Long-term safety of spinal cord stimulation systems in a prospective, global registry of patients with chronic pain. Pain management. 2023 Feb 1;13(2):115-27.
17. Deer TR, Pope JE, Falowski SM, Pilitsis JG, Hunter CW, Burton AW, Connolly AT, Verrills P. Clinical longevity of 106,462 rechargeable and primary cell spinal cord stimulators: real world study in the medicare population. Neuromodulation: Technology at the Neural Interface. 2023 Jan 1;26(1):131-8.
18. Hagedorn JM, Romero J, Ha CT, D'Souza RS. Patient satisfaction with spinal cord stimulation and dorsal root ganglion stimulation for chronic intractable pain: a systematic review and meta-analysis. Neuromodulation: Technology at the Neural Interface. 2022 Oct 1;25(7):947-55.