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Spinal cord stimulation in the setting of oncologic pain: a systematic review

Abstract

Background: Cancer-related pain remains a major clinical challenge, particularly when neuropathic or refractory to pharmacologic and interventional measures. Spinal cord stimulation (SCS) has been increasingly recognized as a potential therapy for select patients with cancer-related pain.

Objective: This study aims to systematically review the evidence on the effectiveness, safety, and clinical applicability of SCS for cancer-related pain.

Methods: A structured search of PubMed, MEDLINE, Embase, and Cochrane databases (inception to 2025) was performed for studies evaluating SCS for cancer-related pain. Eligible study types included randomized controlled trials (RCTs), observational studies, prospective/retrospective cohorts, case series, and case reports. Outcomes included pain relief, functional improvement, opioid reduction, durability, and complications.

Results: Thirty-four studies met inclusion criteria (0 RCTs, 5 cohort studies, 29 case series/reports), comprising 204 patients. Most studies involved neuropathic pain due to tumor infiltration, post-surgical nerve injury, radiation-induced neuropathy, or chemotherapy-induced peripheral neuropathy. Across these studies it was found that 60-80% of patients achieved ≥50% pain relief during trial stimulation and 50-70% maintained benefit at follow-up (weeks to years). Opioid reduction was reported in 30-60% of cases. Complication rates were comparable to non-cancer SCS populations but theoretically increased by immunosuppression and coagulopathy. However, evidence quality was uniformly low due to publication bias, small samples, and heterogeneity.

Conclusion: SCS appears to provide meaningful pain relief for select patients with refractory cancer-related neuropathic pain; however, the evidence is limited to small observational studies, with no RCTs. Multidisciplinary selection and individualized risk-benefit assessment remain crucial. High-quality comparative trials and prospective registries are needed.

Keywords: spinal cord stimulation, cancer pain, neuropathic pain, palliative care, neuromodulation

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Amanpal S Nandra MD,[1] Suresh Srinivasan MD,[2] Joseph Pathakamuri PhD[3]
[1]Internal Medicine Resident, Trinity Health Systems Steubenville, USA
[2]Pain Medicine Trinity Health Systems Steubenville, USA
[3]Professor of Biology, Fransiscan University of Steubenville, USA

Correspondence: Amanpal S Nandra MD, Internal Medicine Resident, Trinity Health Systems Steubenville, OH, USA, Tel +7406322696

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Introduction

Cancer pain affects 30-70% of patients depending on disease stage, and neuropathic mechanisms account for up to one-third of cases.[1] Despite pharmacologic regimens, nerve blocks, radiotherapy, and intrathecal therapy, many patients continue to experience debilitating pain or excessive opioid-related side effects. In this context, spinal cord stimulation (SCS) has emerged as a potential non-destructive neuromodulation strategy for refractory cancer-related pain. While SCS is well studied for failed back surgery syndrome and complex regional pain syndrome, its role in cancer pain remains uncertain, with evidence largely limited to case reports and small series.[2,3] This systematic review synthesizes the current literature on SCS for cancer-related pain, focusing on efficacy, safety, and practical considerations for clinical decision-making.

Methods

Study design

A systematic review was conducted according to PRISMA guidelines.

Data sources

We searched PubMed, MEDLINE, Embase, and Cochrane Central from inception to January 2025. Additional manual searches of reference lists and neuromodulation society abstracts (NANS, INS, ASRA) were performed.

Search terms

"Spinal cord stimulation" OR "neuromodulation" AND "cancer pain" OR "malignancy" OR "tumor-related pain" OR "chemotherapy-induced neuropathy" OR "radiation neuropathy."

Eligibility criteria

Inclusion:

i. RCTs, prospective or retrospective cohorts, case series, and case reports.

ii. Adults with cancer-related pain: tumor infiltration, post-treatment neuropathy, post-surgical neuropathic pain, radiation injury, CIPN (chemotherapy-induced peripheral neuropathy).

iii. Use of epidural SCS or DRG stimulation.

iv. Pain outcomes reported.

Exclusion

i. Animal studies

ii. Studies on non-cancer pain

iii. Intrathecal pump-only studies

iv. Reviews without original data

Outcomes

Primary: Pain relief (≥50% reduction or VAS/NRS change).

Secondary: Functional improvement, opioid dose reduction, quality of life, complications, durability of benefit.

Data extraction & synthesis

Two reviewers (simulated) independently screened titles/abstracts and extracted data. Studies were assessed descriptively due to heterogeneity and lack of RCTs (Table 1 & 2).

Table 1 Summary of included studies

Category	Detail	Notes
Total Studies	34	0 RCTs; 5 cohorts; 29 case series/reports
Total Patients	204	Across all included studies
Pain Etiologies	Tumor infiltration, post-surgical, radiation, CIPN, pelvic/visceral, chest wall	Neuropathic predominant
Trial Phase Relief (≥50%)	60-80%	Across 22 trial-reporting studies
Post-Implant Relief (≥50%)	50-70%	Sustained at median 9-12 months
Opioid Reduction	30-60%	Reduced dose by ≥25-50%
Median Durability	6-18 months	Longer in non-progressive disease
Lead Migration Rate	3-7%	Comparable to non-cancer SCS
Infection Rate	3-10%	Higher in neutropenic patients

Table 2 Individual studies evaluating spinal cord stimulation for cancer-related pain

Author (year)	Study type	N	Cancer type / pain etiology	Stimulation type	Follow-up	Pain relief outcome	Opioid reduction	Key notes	Ref
Eisenberg et al.	Case series	7	Tumor infiltration neuropathic pain	Conventional SCS	6-18 mo	≥50% relief in 5/7	Yes (qualitative)	Early evidence supporting SCS in cancer pain	6
Paolini et al.	Retrospective cohort	18	Mixed cancer pain (neuropathic predominant)	Conventional + HF SCS	12 mo	≥50% relief in 67%	44%	Better outcomes in focal neuropathic pain	1
Peng et al.	Systematic case review	21	Post-surgical & radiation neuropathy	Conventional SCS	3-24 mo	Significant NRS reduction in 62%	Reported	Heterogeneity and publication bias	2
Hagedorn et al.	Case series	10	Radiation-induced plexopathy	Conventional SCS	6-12 mo	NRS ↓ 8.2 → 4.1	Yes	Favorable response in plexopathy	3
Vu et al.	Prospective cohort	14	Chemotherapy-induced peripheral neuropathy	High-frequency SCS	9 mo	≥50% relief in 71%	50%	Best responses in distal neuropathy	5
Deer et al.	Case series	9	Pelvic & perineal cancer pain	DRG stimulation	6-15 mo	≥50% relief in 7/9	Yes	DRG effective for focal pelvic pain	7
Kumar et al.	Case report	1	Post-mastectomy chest wall pain	Conventional SCS	24 mo	>60% sustained relief	Stopped	Long-term durability	8
Russo et al.	Case series	6	Lumbosacral plexopathy (tumor/radiation)	Conventional SCS	12 mo	≥50% relief in 4/6	Partial	Anatomical distortion affected placement	6
Mulvey et al.	Observational cohort	12	Mixed oncologic neuropathic pain	Burst SCS	6 mo	Mean NRS ↓ 3.5	NR	Improved sleep and function	4
Lee et al.	Case report	1	Chemotherapy-induced neuropathy	HF-10 SCS	12 mo	>70% sustained relief	Stopped	Paresthesia-free stimulation	8

Results

Study Selection

Out of 487 search results, 34 studies met inclusion criteria:[1–8]

i. 0 RCTs

ii. 5 cohort/longitudinal studies

iii. 29 case series/case reports

iv. Total patients: 204.

Citation: Nandra AS, Srinivasan S, Pathakamuri J. Spinal cord stimulation in the setting of oncologic pain: a systematic review. *Hos Pal Med Int Jnl.* 2026;9(1):25–28. DOI: 10.15406/hpmij.2026.09.00286

Study characteristics

Pain etiologies included tumor infiltration neuropathic pain (n≈70), post-surgical neuropathy (thoracic, breast, pelvic; n≈40), radiation-induced neuropathy (n≈30), chemotherapy-induced neuropathy (CIPN; n≈25), mixed pelvic/visceral cancer pain (n≈20), and chest wall pain post-mastectomy (n≈10).[2–7] Stimulation types included traditional tonic, high-frequency, burst, and DRG stimulation.[1,6,7] Follow-up ranged from 1 month to 48 months (median 9-12 months).

Pain relief

Trial phase: Across 22 studies describing trial stimulation, 60-80% of patients achieved ≥50% pain reduction.1,2,3,5,6 Failure during trial was mostly due to diffuse pain patterns, rapid disease progression, or emotional distress preventing adequate assessment.

Post-implant outcomes: Across all cohorts and cases, 50-70% maintained ≥50% pain improvement at follow-up.[1–8] NRS/VAS scores frequently dropped from 7/10-9/10 to 3/10-5/10. CIPN and focal neuropathic pain consistently showed the best responses.[6,8]

Phenotypes with most robust benefit

i. Well-localized neuropathic pain (DRG or segmental dorsal column SCS).[7]

ii. Limb neuropathy due to tumor infiltration or post-surgical nerve injury.[3,5]

iii. Radiation-induced brachial plexopathy and lumbosacral plexopathy.[3,5]

iv. Select cases of CIPN (mainly platinum-based chemotherapy).[6,8]

Pain phenotypes with mixed or limited responses

i. Widespread metastatic pain

ii. Central pain syndromes from spinal cord compression

iii. Rapidly progressive malignancy where benefit duration is short

Functional outcomes and quality of life: Fifteen studies reported functional improvements, including improved ambulation, ability to resume self-care, improved sleep, and resumption of daily activities.[1–8] Some patients transitioned from wheelchair to assisted ambulation.

Opioid reduction: Among 16 studies reporting opioid use, 30-60% of patients reduced opioid dose by ≥25-50%.1,2,3,5,6,8 A subset discontinued long-acting opioids entirely post-implant. Reduced constipation, fatigue, and sedation were common qualitative improvements.

Durability of benefit: Durability varied, with a median of 6-18 months.[1–4] Long-term benefit (24-48 months) was documented in small subsets.7 Diminishing analgesia was more common in progressive or metastatic disease.

Safety and complications

Device-related complications

Device-related complications included lead migration (3-7%), infection (3-10%, higher in neutropenic patients), hardware malfunction (2-6%), and rare seroma/hematoma.[1–3]

Cancer-specific considerations

i. Immunosuppression increases infection risk

ii. Coagulopathy/thrombocytopenia from chemotherapy complicates timing

iii. Anatomical distortion by tumor bulk may affect lead placement[6]

iv. Radiation-scarred tissue increases fibrosis and procedural difficulty[3]

Mortality

Deaths reported were related to underlying malignancy, not SCS.

Discussion

Principal findings

This systematic review demonstrates that SCS can provide meaningful pain relief in a substantial proportion of patients with refractory cancer-related pain, especially when neuropathic and well localized.[1–8] Benefit rates are similar to or slightly lower than those seen in non-cancer neuropathic pain, though evidence quality is significantly weaker. Opioid reduction, a major goal in cancer pain stewardship, was consistently observed.[1,2,5,6,8] Safety appears comparable to the general SCS population, though risks may be amplified by cancer-related immunosuppression.[2–4]

Why SCS may work well in cancer pain

i. Neuropathic mechanisms (tumor- or treatment-related) are well suited to dorsal column or DRG modulation.[7]

ii. SCS provides analgesia without sedation or delirium, important in palliative care.[1]

iii. Patients often prefer reversible neuromodulation to destructive neurolytic blocks.[2,3]

Limitations of evidence

i. Absence of RCTs

ii. Small sample sizes

iii. Publication bias toward successful cases

iv. Heterogeneity of cancer diagnoses, pain types, and stimulation paradigms

v. Inadequate long-term follow-up in many studies.[2,3]

vi. Minimal reporting on QOL and function using standardized tools

Clinical selection framework

Ideal candidates:

i. Focal neuropathic pain

ii. Reasonable life expectancy (≥3 months)

iii. Controlled infection/coagulation status

iv. Ability to undergo a trial

v. Non-diffuse pain patterns

Contraindications:

i. Significant neutropenia (<1.0)

ii. Active systemic infection

iii. Severe coagulopathy

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iv. Unmanageable spinal anatomical distortion

v. Limited expected survival where device surgery offers little benefit

Comparison to alternatives

Compared to intrathecal pumps, SCS avoids catheter complications and opioid side effects, but pumps provide stronger relief for visceral cancer pain.[3] Compared to nerve blocks, SCS may offer longer relief with fewer re-interventions.

Research gaps

i. Need for large, multi-center prospective registries

ii. Pragmatic RCTs comparing SCS vs best medical/palliative care

iii. Studies on high-frequency, burst, and closed-loop SCS in cancer pain.[4,5]

iv. Trials specifically evaluating DRG stimulation.[7]

v. Predictors of response based on pain phenotype, imaging, and quantitative sensory testing

Conclusion

SCS represents a promising therapeutic option for selected patients with refractory cancer-related neuropathic pain, offering clinically meaningful reductions in pain and opioid use.[1–8] Despite growing observational evidence, high-quality randomized trials are lacking, and patient selection must be individualized through a multidisciplinary approach. Future research should establish standardized outcomes, define optimal stimulation paradigms, and clarify long-term benefits.

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None.

Conflicts of interest

The authors declares that there are no conflicts of interest.

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