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The Role of Quantitative Sensory Testing in Spinal Cord Stimulation for pain: A Systematic Review

Short Title: Quantitative Sensory Testing (QST) in Predicting Outcomes for Spinal Cord Stimulation (SCS) for Neuropathic Pain

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INTRODUCTION

Spinal Cord Stimulation (SCS) is an effective intervention for refractory pain, yet patient response remains variable. Quantitative Sensory Testing (QST), a standardized psychophysical test, offers a structured method to assess somatosensory function and may identify predictors of SCS treatment response. QST involves the application of calibrated mechanical, thermal, or vibratory stimuli to assess sensory detection and pain thresholds across different fiber types (Aβ, Aδ, C). When used together, QST and SCS offer a powerful clinical and research framework to better understand, predict, and treat refractory pain.

MATERIALS AND METHODS

A systematic review of Ovid MEDLINE (1946–March 2025) was conducted after registering the protocol on PROSPERO to identify studies using QST before and/or after SCS in adults with refractory pain. Eligible studies included randomized trials, prospective cohorts, and observational studies. Outcomes focused on QST modalities such as pressure pain threshold, temporal summation, conditioned pain modulation, and thermal/mechanical thresholds.

CONCLUSION

QST detects clinically meaningful sensory changes post-SCS implant and may help predict responders, particularly through dynamic measures like TS. Standardized QST protocols and multimodal assessments are needed to optimize personalized SCS therapy. Integrating QST into pre-SCS assessment could improve patient selection and allow clinicians to better predict therapeutic outcomes.

Authors & Year	Mean Age	Diagnosis	Pain Duration (yrs)	Pain Intensity (NRS)	QST Timing	QST Modalities	Results
Eisenberg et al., 2006	Not specified	FBSS, CRPS	>6	8.05 ± 1.14	Baseline, 7 days post-trial, post-full	Vibration, Electrical	↑ Vibration threshold, ↑ Electrical pain tolerance (5 & 250 Hz)
Schuh-Hofer et al., 2018	55.5 ± 10.6	Neuropathic pain	Not specified	6.06 ± 0.64	SCS ON/OFF (60 min rest)	CPM, Temporal Summation	↑ CPM (p=0.033), ↓ Temporal Summation (p=0.04)
Campbell et al., 2015	51.6 ± 13.3	FBSS, CRPS	5.5 (resp.), 12.5 (non-resp.)	7.83 ± 0.86	Pre, Post-trial, 3-month FU	PPT, TS, CPM	↑ TS reduction predicted pain relief, ↓ CPM
Morgalla et al., 2022	58.4	FBSS, CRPS	Not specified	5.1 ± 1.2	Pre-SCS, Tonic vs BurstDR	VDT, MPT, CPT, HPT	BurstDR > Tonic for Aβ & Aδ function
Rasche et al., 2006	52	Radicular pain	Not specified	Not specified	SCS ON/OFF	Thermal, Mechanical	↑ Cold/warm detection, ↓ Mechanical thresholds
Meier et al., 2015	~54 (32–67)	FBSS, Neuropathic pain	Not specified	Not specified	SCS ON 24h ref, ON/OFF (10–12h)	HPT, MPT	No change except ↑ HPT (p=0.01)
Sankarasubramanian et al., 2021	~48.7 (25–66)	Neuropathic pain	Not specified	Not specified	Baseline, 7–10 days post-trial, 4–6 weeks post-implant	PPT, TS, CPM	↑ PPT, ↓ TS, No CPM effect
Ahmed et al., 2015	~53 (29–55)	Neuropathic pain	Not specified	Not specified	SCS ON/OFF	HPT, WDT	↑ Heat pain & warm thresholds (p<0.05)
Bordeleau et al., 2020	Not specified	Neuropathic pain	18.1 (mean)	7.1 ± 1.4	SCS ON/OFF	Mechanical, Thermal	No major change except ↓ Mechanical summation (p=0.03)
Plantaz et al., 2022	~49.5 (40.5–59)	PSPS	Not specified	Not specified	Pre, 2w, 3m, 6m post	PPT, EPT	↑ PPT, ↑ EPT, ↓ Allodynia
Kriek et al., 2023	Not specified	CRPS	2 (median)	7 (median)	Baseline, 3m post-SCS	CPT, PTT, CPM	↓ Allodynia & Hyperalgesia, ↑ CPM
Eisenberg et al., 2015	~59 (47–72)	Neuropathic pain	11.3 ± 5.3	6.6 ± 1.8	ON 30min, OFF 2h (or reverse)	TS, CPM	↓ TS, No CPM effect

Table 1. Summary of included studies evaluating QST for predicting SCS outcomes.

CMP - Conditioned Pain Modulation; TS – Temporal Summation; PPT – Pressure Pain Threshold; EPT – Electrical Pain Threshold; PTT – Pain Tolerance Time; CPT – Cold Pain Threshold; HPT – Heat Pain Threshold; WDT – Warm Detection Threshold; MPT – Mechanical Pain Threshold; VDT – Vibration Detection Threshold; MPS – Mechanical Pain Sensitivity; DMA – Dynamic Mechanical Allodynia; TSL – Thermal Sensory Limen.

RESULTS

12 studies were included (191 patients; mean age 53.5 years).

- Diagnoses:
  Persistent Spinal Pain Syndrome (PSPS): 67.5%
  Complex Regional Pain Syndrome (CRPS): 21.8%

Key findings:

- **Decreased temporal summation, indicating reduced central sensitization, in 6 studies.**
- **Increased conditioned pain modulation, suggesting restored descending inhibition of pain in 3 studies.**
- **Increased sensory thresholds indicating reduced sensitization in 5 studies.**
- **Higher baseline TS was correlated with better pain relief in 2 studies.**

- Evidence synthesis was limited due to heterogeneity in QST protocols, timing of assessments, outcome definitions.

REFERENCES

1.Schuh-Hofer, et al. Spinal cord stimulation modulates descending pain inhibition and temporal summation of pricking pain in patients with neuropathic pain. Neuromodulation. 2018;21(7):625–633.

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