



Use of High-Frequency (10-kHz) Spinal Cord Stimulation for Painful Diabetic Neuropathy: A Literature Review

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Introduction

Approximately 30-50% of adults with diabetes experience diabetic peripheral neuropathy with symptoms such as paresthesias, numbness, burning, tingling, and shooting pain in a distal symmetric stocking glove distribution. This condition is linked to significant morbidity, ultimately resulting in a profound impact on the affected individuals' quality of life. Nearly half of the patients do not experience relief from current treatments leading to the use of opioids and prompting some patients to seek alternative therapeutic options. Spinal cord stimulation (SCS) is an evidence-based therapeutic modality for patients with diabetic neuropathy. High-frequency (10-kHz) spinal cord stimulation represents a relatively novel method in pain management and unlike traditional SCS, which utilizes lower frequencies, 10-kHz stimulation involves applying a higher frequency to the spinal cord.

Methods

A systematic literature search was performed on PubMed to identify studies reporting outcomes for high frequency (10 Hz) SCS in painful diabetic neuropathy. A total of 8 publications were included in this review: four randomized control studies, two cohort studies, one prospective study, one retrospective study.



Scan for Abstract and References

Type of Study	Title	First Author	Main Findings	Year of Publication
Cohort	Painful Diabetic Neuropathy—Patients Treated with High-Frequency (10 kHz) Spinal Cord Stimulation (SCS) Experience Significant Reductions in A1C and Weight.	D.C. Klonoff	High-frequency (SCS) has demonstrated positive outcomes in pain management and sensory function improvement, along with notable reductions in A1C levels and weight	2023
RCT	Durability of High-Frequency 10-kHz Spinal Cord Stimulation for Patients With Painful Diabetic Neuropathy Refractory to Conventional Treatments: 12-Month Results From a Randomized Controlled Trial	E. A. Petersen	79.5% of patients using high-frequency SCS achieved at least 50% pain relief compared to their baseline	2022
Cohort	A Real-World Analysis of High-Frequency 10 kHz Spinal Cord Stimulation for the Treatment of Painful Diabetic Peripheral Neuropathy. Journal of Diabetes Science and Technology.	J. L. Chen	SCS led to significant enhancements in neurological function, especially in sensory perception using a 10-g monofilament and pinprick test	2022
RCT	Neuromodulation in the Treatment of Painful Diabetic Neuropathy: A Review of Evidence for Spinal Cord Stimulation. Journal of Diabetes Science and Technology.	N. H. Stran	Patients treated with the 10 kHz SCS experienced an average pain relief of 76%	2022
RCT	Effect of High-frequency (10-kHz) Spinal Cord Stimulation in Patients With Painful Diabetic Neuropathy: A Randomized Clinical	E. A. Petersen	In resistant PDN, 10-kHz SCS provided substantial pain relief and long-term improvements in quality of life for up to 6 months and 1 year	2021
RCT	High-Frequency 10-kHz Spinal Cord Stimulation Improves Health-Related Quality of Life in Patients With Refractory Painful Diabetic Neuropathy: 12-Month Results From a Randomized Controlled Trial	E. A. Petersen	Participants reported less pain interference with sleep, mood, and daily activities	2022
RS	A Real-World Analysis of High-Frequency 10 kHz Spinal Cord Stimulation for the Treatment of Painful Diabetic Peripheral Neuropathy	J. L. Chen	Real-world study in typical clinical practices found 10 kHz SCS provided meaningful pain relief for a substantial portion of patients refractor to current pDPN management	2021
PS	10-KHz Spinal Cord Stimulation Treatment for Painful Diabetic Neuropathy: Results from Post-Hoc Analysis of the Senza-PPN Study.	V. Galan	70% pain reduction as compared to 50-60% with low frequency SCS within a week of initiating 10-kHz stimulation for 1 year	2020

RCT = Randomized Control Trial; RS = Retrospective Study; PS = Progressive Study; SCS = Spinal Cord Stimulation; pDPN = painful diabetic peripheral neuropathy

Discussion

High-frequency spinal cord stimulation resulted in pain relief and improved sensory function, in addition to observed reductions in A1C levels and weight. These findings offer further evidence in favor of utilizing 10 kHz SCS therapy as a comprehensive treatment for patients with type 2 diabetes experiencing painful diabetic neuropathy (1).

In one randomized controlled trial, participants demonstrated neurological improvements, particularly in sensory function, over the span of 1 year (2).

In a cohort study, 79.5% of patients using a high-frequency spinal cord stimulator achieved a minimum of 50% pain relief compared to their initial baseline. Additionally, significant improvements in neurological function, particularly in sensory perception of 10-g monofilament and pinprick, were noted in 62% of patients using the device after 6 months. In contrast, only 3% of patients in the medical management arm demonstrated similar improvements during the same timeframe (3). In another randomized controlled study comparing 10 kHz SCS against conventional medical management in 216 participants with PDN, it was found that after six months of stimulation, the 10 kHz SCS group experienced an average pain relief of 76% (4).

A randomized controlled study demonstrated that 10-kHz SCS is an efficient therapy for patients with resistant painful diabetic neuropathy as it offers substantial pain relief and long-term enhancements in the quality of life for up to 6 months. Earlier randomized controlled trial data with low-frequency SCS indicated that only half of the participants achieved notable pain relief at night. However, this particular study reveals that 10-kHz SCS significantly enhances sleep quality for patients with PDN (5). A year followup from this study showed that neurological improvements in sensory function were sustained over a 12-month period for most patients who received 10-kHz SCS.

Participants reported significantly less pain interference with sleep, mood, and daily activities. In this retrospective study, a majority of patients also reported improvements in their sleep and overall function relative to their baseline. The prospective study showed 70% reduction in pain after a week of initiating the 10-kHz stimulation and continued throughout the entire 12-month period of treatment. Previous studies on LF-SCS for treating painful PDN have shown pain relief ranging from 50% to 60%.

Conclusions

The literature in this review supports high frequency (10Hz) SCS showing favorable outcomes in terms of pain reduction (VAS score) and in quality of life scores (EQ-5D-5L) than other neuromodulation therapies available in treating diabetic neuropathy. High frequency (10Hz) SCS is a safe, minimally invasive, and reversible therapeutic agent for managing painful diabetic neuropathy and improving the overall quality of life of PDN patients.