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Chronic epidural electrical stimulation of lumbar enlargement for pain relief after ineffective neurolysis in patients with post-traumatic sciatic neuropathy

© V.P. Kondratyev, A.V. Dekopov, E.D. Isagulyan, A.A. Tomskiy

Burdenko Neurosurgical Center, Moscow, Russia

ABSTRACT

Introduction. Peripheral nerveinjuries affect approximately 200.000 patients annually in Russia, and sciatic nerve injuries constitute about 8.3% (~16.600 cases). Many patients develop chronic neuropathic pain refractory to standard therapy. Surgical neurolysis provides adequate relief in only 50—80% of cases, and effective alternatives are needed for other patients. Chronic spinal cord stimulation (SCS) is a promising modality for these patients.

Objective. To evaluate efficacy and safety of chronic SCS for chronic pain due to post-traumatic sciatic neuropathy refractory to conservative therapy and neurolysis.

Material and methods. A retrospective single-center study included 10 patients with persistent neuropathic pain despite prior pharmacotherapy and neurolysis. All patients underwent SCS with pain assessment. The primary efficacy criterion was reduction of VAS score ≥50% after test stimulation period.

Results. Positive responses were achieved in 9 out of 10 patients (90%). Mean VAS scores significantly decreased from 7.9±1.3 to 3.3±1.5 (p=0.007). Therapeutic effect was maintained in all responders throughout the follow-up period (3 months-2 years) without complications.

Conclusion. Chronic SCS is a highly effective and safe treatment for chronic pain in patients with post-traumatic sciatic neuropathy resistant to standard therapies. These results justify SCS in such clinical scenarios and highlight the need for further prospective studies.

Keywords: *sciatic nerve, neurostimulation, spinal cord stimulation, neuropathy, systematic review.*

INFORMATION ABOUT THE AUTHORS:
Kondratyev V.P. — https://orcid.org/0000-0003-3272-8699
Dekopov A.V. — https://orcid.org/0000-0002-3834-5579
Isagulyan E.D. — https://orcid.org/0000-0003-1191-9357
Tomskiy A.A. — https://orcid.org/0000-0002-2120-0146
Corresponding author: Kondratyev V.P. — e-mail: stenv@gmail.com

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Abbreviations

SCS — spinal cord stimulation
PNS — peripheral nerve stimulation
VAS — visual analogue scale

Introduction

According to official statistical data, 12.5 million visits for various injuries were registered in Russia in 2022 [1]. Peripheral nerve injuries account for 1.6% of all injuries that amounts to approximately 200.000 patients per year [2]. Sciatic nerve injuries account for 8.3% of this category. Thus, sciatic nerve injuries are annually diagnosed in 16.600 people.

The key clinical manifestations of sciatic neuropathy are pain and weakness in distal lower limb. Currently, standard treatment algorithm for such injuries includes therapy and, if this is ineffective, surgical intervention (neurolysis and/or nerve reconstruction). Importantly, pain reduction by ⩾ 50% of baseline scores after neurolysis is achieved in only 50—80% of patients [3]. Other patients develop chronic pain that not only significantly reduces quality of life and working capacity, but also creates a significant economic burden on healthcare system [2].

SCS is one of the methods for treating chronic neuropathic pain syndrome.

The purpose of this study was to evaluate clinical efficacy of chronic SCS in patients with post-traumatic sciatic neuropathy resistant to therapy and surgical neurolysis.

***Table*. Demographic characteristics.**

Age, years	40.1±15.0
Sex, *n*	Male — 6 Female — 4
Cause of injury, *n*	Post-injection — 2 Hip replacement — 1 Road accident — 2 Mine-explosive injury — 5
Period between injury and neurolysis, months	13.8±10.7
Period between neurolysis and SCS, months	26.8±46.2
VAS score of pain before SCS	7.9±1.3
VAS score of pain under SCS	3.3±1.5

Material and methods

A retrospective single-center observational study analyzed the feasibility and efficacy of chronic SCS for chronic pain syndrome. The study was conducted at the Burdenko Neurosurgery Center (Moscow) between November 2022 and October 2025.

Inclusion criteria:

— post-traumatic sciatic neuropathy accompanied by persistent pain;

— ineffectiveness of adequate therapy for at least 3 months;

— previous sciatic neurolysis without sufficient pain relief.

Exclusion criteria:

— patient refusal to participate in the study;

— endogenous mental illness.

All patients underwent implantation of eight-contact cylindrical electrodes for SCS. Electrodes were implanted via puncture into posterior epidural space at the level of Th10—Th12 under radiographic guidance. Test stimulation period followed implantation and lasted 4-7 days. This period was successful if pain reduced by ⩾50% under SCS. Patients with positive test period were subsequently implanted with permanent neurostimulation system consisting of electrodes and subcutaneous pulse generator. Electrodes were implanted in the same manner, and subcutaneous pulse generator was positioned in the left upper gluteal region.

The system was programmed using the following parameters: stimulation frequency 70—120 Hz, pulse duration 300—350 μs and individual amplitude until comfortable paresthesia covering painful area.

VAS score of pain were assessed preoperatively and after 5—7-day SCS. VAS score reduction by ⩾50% from baseline values implied effective stimulation. If the method was effective, patients were implanted with chronic SCS system with subsequent assessment after 3, 6, and 12 months and then annually.

Statistical analysis was performed using the TIBCO Statistica® Document Management System 13.3.0 software package (TIBCO Software Inc., USA). The non-parametric Wilcoxon signed-rank test was used to compare dependent samples with non-parametric distribution.

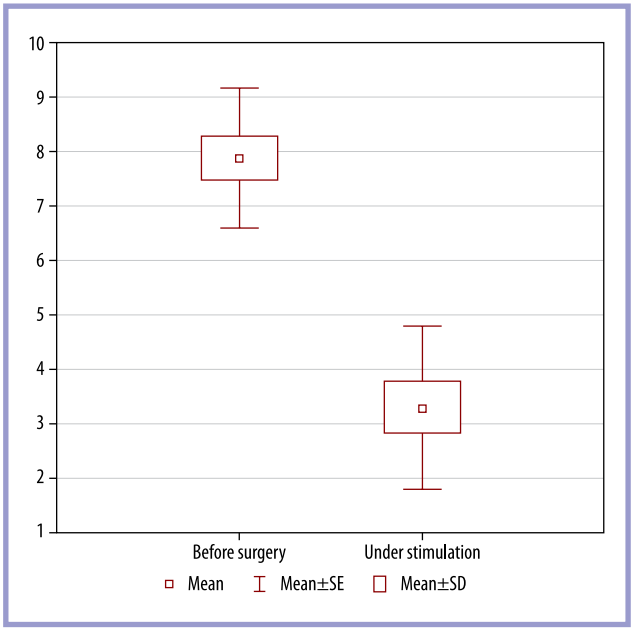

***Figure*. Preoperative and postoperative pain syndrome.**

Results

The study included 10 patients with chronic neuropathic pain syndrome due to drug-resistant post-traumatic sciatic neuropathy. Demographic characteristics are presented in **Table. Patient** ages ranged from 22 to 70 years (mean 40.1±15.0).

All patients had drug-resistant pain syndrome including ineffective first-line medications for neuropathic pain, such as pregabalin or gabapentin, at maximum doses up to 600 and 3600 mg/day, respectively. Additionally, antidepressants with antinociceptive activity, namely duloxetine or amitriptyline, were used at maximum doses. Duration of therapy was at least 3 months.

Furthermore, all patients underwent surgical neurolysis and sciatic nerve decompression after ineffective conservative treatment. These measures were also ineffective. Three patients experienced deterioration of pain in delayed period after neurolysis.

Mean period between injury and neurolysis was 13.8±10.7 months, between neurolysis and SCS system implantation — 26.8±46.2 months.

There were the following causes of sciatic nerve injury: 2 patients after road accident with pelvic fracture; 1 patient with iatrogenic injury following hip replacement; 2 patients after unsuccessful intramuscular injection of medications (nonsteroidal anti-inflammatory drug and third-generation cephalosporin antibiotic); 5 patients with mine-explosive injury of the thigh.

SCS reduced pain by ⩾50% in 9 (90%) out of 10 patients. Among responders, pain reduction ranged from 57% to 75%. In one non-responder, pain intensity remained the same. Therefore, electrode was removed after test period in this patient. Other nine patients were successfully implanted with chronic SCS system.

Mean pain reduction across the entire group was 58.2%. VAS scores significantly reduced from 7.9±1.3 preoperatively to 3.3±1.5 postoperatively (p=0.007) **(Figure)**.

The follow-up period for patients with implanted systems ranged from 3 months to 2 years. Throughout the entire follow-up period, no patient demonstrated decrease in effectiveness of chronic stimulation in relieving pain. There were no intra- or postoperative complications related to system implantation or stimulation.

Discussion

Our retrospective study demonstrates high clinical efficacy of chronic SCS for chronic drug-resistant neuropathic pain in patients with post-traumatic sciatic neuropathy refractory to therapy and neurolysis. Pain reduction by ⩾50% was achieved in 90% of patients. Mean VAS score reduction was 58.2% (statistically and clinically significant result).

Our findings are consistent with literature data on effectiveness of SCS for various neuropathic pains. Specifically, meta-analyses demonstrate that SCS provides clinically significant pain reduction in 68—86% of patients with chronic neuropathic pain following peripheral nerve injury with 45—73% pain reduction [4, 5]. A 90% efficacy rate in our study slightly exceeds this range. This discrepancy can be explained by limitations inherent in retrospective design and small sample size, as well as by possible influence of careful patient selection (those with completely exhausted all other standard treatment options).

PNS is an alternative treatment for chronic neuropathic pain syndrome. According to systematic reviews and meta-analyses, its effectiveness in pain relief is comparable to SCS (52—70% pain reduction in 65—80% of patients) [6, 7]. There are some potential advantages of PNS including lower incidence of electrode migration, reduced dependence of stimulation amplitude on patient position changes, easy system programming and easy achievement of complete coverage of painful area with paresthesia.

A key limitation of PNS for post-traumatic neuropathies is technical complexity of electrode implantation. The last one requires neurolysis of the target nerve. According to large reviews and guidelines, neurolysis and electrode implantation can be associated with significant technical difficulties and increased risks, especially in patients with adhesions after previous surgical interventions [8]. Therefore, SCS appears preferable if neurolysis is deemed inappropriate or unsuccessful. At the same time, neurolysis simultaneously with PNS electrode implantation mitigates the aforementioned difficulties.

According to classical theory, chronic stimulation reduces pain through «gating control», i. e. activation of large Aβ fibers blocking transmission of pain signals along small C-fibers in spinal cord. However, subsequent studies revealed more complex mechanisms underlying this including peripheral (reduced C-fiber excitability, release of serotonin and endorphins, suppression of neurogenic inflammation) and central (changes of spinal cord and brain activity, including somatosensory cortex, thalamus and cingulate gyrus, modulation of neurotransmitter systems — gamma-aminobutyric acid, glycine, dopamine, and serotonin) ones. These mechanisms together explain cumulative and complex antinociceptive effect of stimulation [9].

SCS was ineffective in one patient. We hypothesize that possible cause of failure is severe central sensitization with persistent supraspinal focus of pathological activity. Indeed, this patient experienced the longest (over 3 years) period between injury and neurolysis in the entire cohort. According to literature data, prolonged period can contribute to centralization of pain syndrome [10—12].

Interpretation of results requires consideration of study limitations. These are retrospective design, no control group and small sample size (n=10). These factors prevent us from excluding the influence of placebo, limit statistical power and subgroup analysis.

To verify our results and draw definitive conclusions, further prospective, randomized, and controlled studies involving larger samples and long-term follow-up are needed. Furthermore, identifying predictors of SCS efficacy appears to be a promising direction. This will allow for optimization of patient selection for this treatment method in the future.

Conclusion

Chronic spinal cord stimulation is a highly effective treatment for chronic drug-resistant pain in patients with post-traumatic sciatic neuropathy refractory to therapy and surgical neurolysis. SCS achieves significant therapeutic effects in 90% of patients.

To confirm appropriate data and identify predictors of effective SCS, prospective randomized controlled trials with large samples and long-term follow-up are needed.

Author contribution:
Concept and design of the study — Kondratiev V.P., Tomskiy A.A.
Collection and analysis of data — Kondratiev V.P., Dekopov A.V., Isagulyan E.D.
Writing the text — Dekopov A.V.
Editing — Tomskiy A.A., Isagulyan E.D.

The authors declare no conflicts of interests.

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COMMENT

High clinical efficacy of chronic spinal cord stimulation for chronic drug-resistant neuropathic pain syndrome in patients with post-traumatic sciatic neuropathy refractory to therapy and neurolysis demonstrates the most appropriate use of chronic epidural stimulation for peripheral neuropathies. Appropriate patients had no somatization of neurological disorders with involvement of central thalamic structures in pain perception. A 50% pain reduction is a statistically and clinically significant result. These data should be compared with results of peripheral nerve stimulation, where electrode placement on the nerve can provide the greatest stimulation effectiveness. Peripheral stimulation implies open procedure, unlike percutaneous spinal cord stimulation. These results may be extremely useful due to widespread use of this method and high incidence of such neuropathies.

Gushcha A.O. (Moscow)