



Epidural spinal cord stimulation for the management of orthostatic hypotension in Parkinson's disease: A case report

Dear Editor,

Parkinson's disease (PD) therapies predominantly target motor symptoms via dopaminergic agents and deep brain stimulation (DBS), yet critical non-motor symptoms like orthostatic hypotension (OH) remain overlooked. Affecting 30–70 % of PD patients [1], OH elevates mortality risk for 1.6 to 2.4 times [2] and drives profound disability through syncope-induced injuries and cognitive impairment [1]. Anti-parkinsonian drugs worsen OH, DBS exhibits uncertain or unremarkable effects on OH [3], and existing medication used to treat OH can have the potential to exacerbate supine hypertension [1]. This paradox leaves PD patients with preserved motor function debilitated by OH-induced disability.

Building on epidural spinal cord stimulation (eSCS) success in treating OH in spinal cord injury [4] and multiple system atrophy [5], we pioneer its application in PD-OH management, addressing a critical unmet need in the subset of patients where OH-mediated disability supersedes motor symptom burden.

This study received ethics approval from Ruijin Hospital, Shanghai Jiao Tong University School of Medicine (NCT05171205). A 69-year-old male with 15-year PD history [6], bedridden for 3 years secondary to profound OH with frequent syncope, underwent eSCS implantation after failed pharmacological (droxidopa/midodrine) and non-pharmacological modalities. A surgical paddle lead (5-6-5 contacts, 977C165, Medtronic, Minneapolis, MN) was epidurally implanted at T10-T11, connected to a subcutaneous abdominal neurostimulator (model 37702, Medtronic, Minneapolis, MN) in the left lower abdominal quadrant.

The optimal electrode configuration and stimulation parameters for blood pressure (BP) management after implantation were determined during the upright seated position as follows: cathode at electrode 0 and anode at electrode 5, with a pulse width of 150 μ s, a frequency of 65 Hz, and a voltage of 5V (Fig. 1, I). Pre-/post-implantation 70° tilt-table tests (TTT) with continuous cardiovascular monitoring (EMS-9D PRO, DELICA Corporation, ShenZhen, China) assessed OH severity and therapeutic response (Fig. 1, II). The same electrode configuration was used in TTT as in seated position, except that voltage was increased to 6V to achieve optimal BP response. Cardiovascular monitoring included continuous beat by beat BP, middle cerebral artery (MCA) blood flow velocity, electrocardiogram (ECG) (EMS-9D PRO, DELICA Corporation, ShenZhen, China), and multichannel functional near-infrared spectroscopy (fNIRS) (ETG-4100, Hitachi Corporation, Tokyo, Japan). Visual analogue scale (0–10) of OH-related symptoms rated by patient before and during TTT with and without eSCS also contributed to assessment of OH severity. Functional evaluations incorporated 6-min walk test (6MWT), Stroop color and word test (SCWT), 24-h ambulatory blood pressure monitoring (ABPM) (Norav NBP-24 NG, Jaken Medical Inc.,

California).

Assessments were conducted at baseline, 3-day (eSCS-ON), and 3-month (eSCS-ON/OFF) post implantation. Triplicate 24-h spaced assessments ensured reproducibility. Data was expressed as mean $\pm$ standard deviation (SD). Pre-post implantation comparisons used unpaired t-tests.

Pre-implantation TTT revealed profound symptomatic OH, accompanied by reduced MCA blood flow, diminished prefrontal cortex oxygenated hemoglobin (Fig. 1, II, C-G), and cognitive impairment (Supplementary Table 1). The patient exhibited marked functional disability with 20-h daily bed confinement (Fig. 1, III, M, Supplementary Table 1) due to recurrent syncope and debilitating symptoms (dizziness/lightheadedness/blurred vision) (Supplementary Table 2).

Remarkably, within 3 days of eSCS activation, the patient demonstrated reduced OH severity (Fig. 1, II, C, D), complete resolution of OH-related symptoms (Supplementary Table 2), and improved cognitive performance (Supplementary Table 1).

Three-month sustained eSCS application yielded enhanced therapeutic outcomes. TTT evaluation achieved superior orthostatic hemodynamic stabilization with complete syncope resolution (systolic BP reduction: 18.6 mmHg with eSCS-ON vs. 64.2 mmHg with eSCS-OFF, Fig. 1, II, H) and augmented cerebral perfusion (Fig. 1, II, K, L), alongside with better cognitive recovery (Supplementary Table 1). PD motor assessment by Movement Disorder Society-sponsored revision of the Unified Parkinson's Disease Rating Scale part III remained stable (before implantation: 49; 3 months post-implantation: 43), whereas OH amelioration drove profound quality-of-life enhancement with progressive functional recovery without anti-parkinsonian medications. Walking and standing capacity quadrupled (0 $\rightarrow$ 4h/day), seated endurance doubled (4 $\rightarrow$ 10h/day), bed-ridden duration halved (20 $\rightarrow$ 10h/day), and 6MWT mobility surged by 150.4 % (Fig. 1, III, Supplementary Table 1).

We present the first successful application of eSCS for managing debilitating OH in individual with PD. In this PD patient with moderate motor dysfunction but debilitating OH, conventional motor-focused therapies were ineffective. Our eSCS treatment alleviated OH, resolved syncopal episodes and restored cerebral perfusion, which translated to functional independence - from bed confinement to autonomous ambulation. No pharmacologic treatment is used. Spinal cord neuromodulation targeting thoracic sympathetic circuits [7] reorients therapeutic priorities in this subset of PD patients, prioritizing autonomic stabilization over motor symptom management when dysautonomia dictates functional disability.

<https://doi.org/10.1016/j.brs.2025.07.011>

Received 9 June 2025; Received in revised form 15 July 2025; Accepted 15 July 2025

Available online 18 July 2025

1935-861X/© 2025 The Authors. Published by Elsevier Inc. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

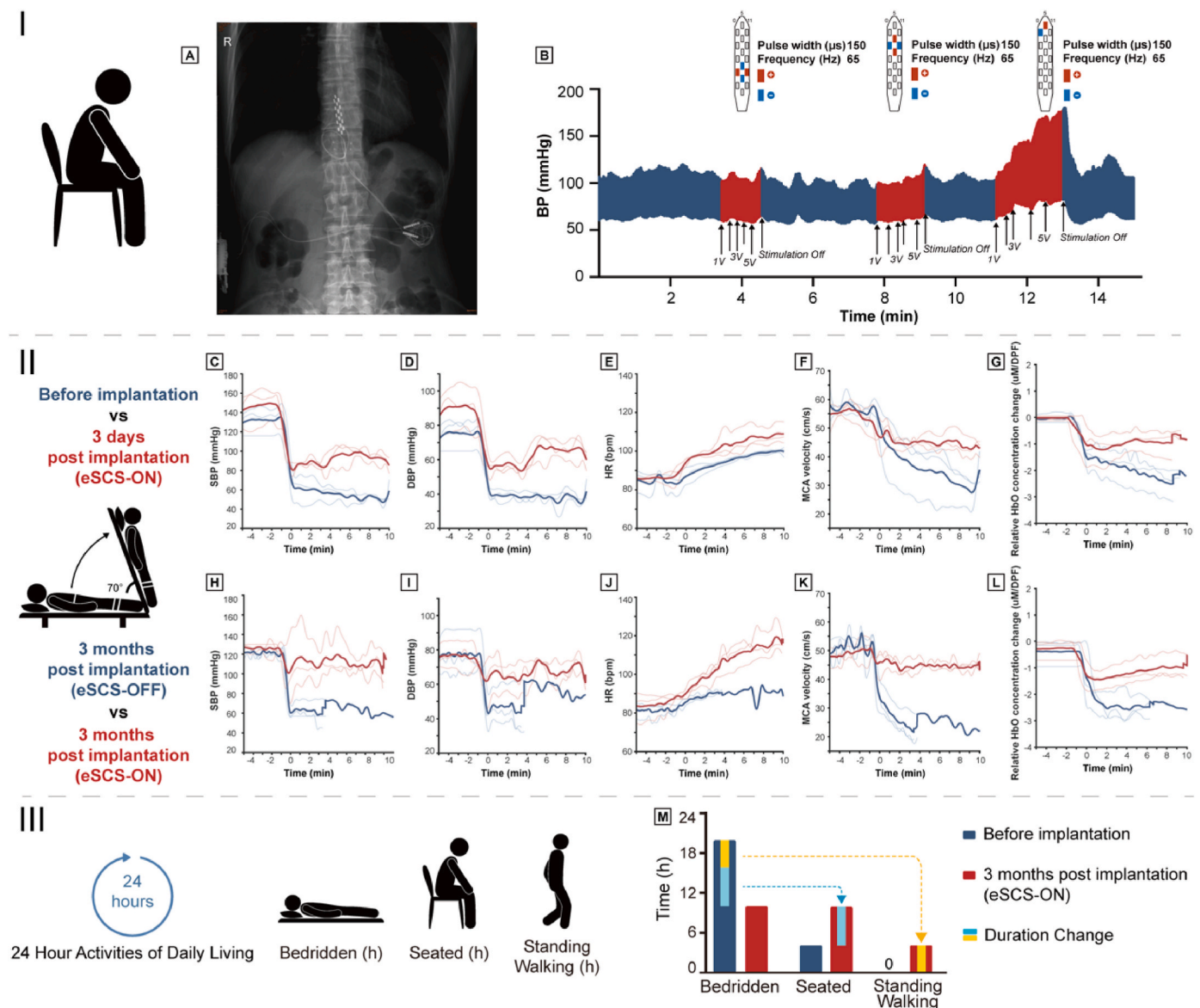


Fig. 1. Mapping and TTT Sessions Results, 24-h Mobility Monitoring.

I. Seated mapping: A) Thorax X-ray with lead position. B) Seated mapping of different electrodes configurations with the last configuration (positive electrode: number 5, negative electrode: number 0) to be the best for BP support. Red, positive electrode; blue, negative electrode.

II. TTT: C)–G): Before implantation and 3 days post implantation eSCS-ON during TTT. C) SBP. D) DBP. E) HR. F) MCA mean velocity. G) Relative HbO concentration change. H)–L): ESCS OFF-ON comparison 3 months after surgery during TTT. H) SBP. I) DBP. J) HR. K) MCA mean velocity. L) Relative HbO concentration change. Red thick line, mean result of eSCS-ON 3 days after surgery/3 months after surgery; red thin line, individual session result of eSCS-ON 3 days after surgery/3 months after surgery; blue thick line, mean result of session results of before implantation/eSCS-OFF 3 months after surgery; blue thin line, individual session result of before implantation/eSCS-OFF 3 months after surgery.

III. 24-hour mobility monitoring: O) The amount of time spent in bedridden, seated, and standing/walking positions over a 24-h period.

Dark blue bar, time spend in each position before implantation; red bar, time spend in each position 3 months after implantation with eSCS-ON; light blue rectangle, duration change from bedridden to seated position 3 months after surgery with eSCS-ON; yellow rectangle, duration change from bedridden to standing and walking position 3 months after surgery with eSCS-ON.

Abbreviations: DBP, diastolic blood pressure; eSCS, epidural spinal cord stimulation; HbO, oxygenated hemoglobin; HR, heart rate; MCA, middle cerebral artery; SBP, systolic blood pressure; TTT, tilt table test.

CRediT authorship contribution statement

Xue Zhu: Writing – original draft, Visualization, Methodology, Funding acquisition, Formal analysis, Data curation. **Yuyan Tan:** Writing – original draft, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation. **Zhuokun Gu:** Writing – original draft, Visualization, Formal analysis, Data curation. **Yuchao Yang:** Writing – original draft, Software, Resources, Formal analysis, Data curation. **Ningyuan Wang:** Writing – original draft,

Software, Resources, Data curation. **Qianyi Yin:** Software, Resources, Data curation. **Sijia Huang:** Software, Resources, Data curation. **Zhengyu Lin:** Resources, Methodology, Data curation. **Peng Huang:** Resources, Methodology, Data curation. **Dianyou Li:** Resources, Methodology, Data curation. **Andrei Krassioukov:** Writing – review & editing, Supervision, Project administration, Formal analysis, Conceptualization. **Jun Liu:** Writing – review & editing, Supervision, Project administration, Funding acquisition, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgments

J. L. was funded by National Natural Science Foundation of China (82230040, 82341251), Shanghai Municipal Health Commission (202440091), Shanghai Research Doctor Program (SHDC2023CRT014) and Shanghai Jiaotong University STAR Program (20220103). X. Z. was funded by China Postdoctoral Science Foundation (2024M762408).

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.brs.2025.07.011>.

References

- [1] Palma JA, Kaufmann H. Orthostatic hypotension in Parkinson disease. *Clin Geriatr Med* 2020;36:53–67. <https://doi.org/10.1016/j.cger.2019.09.002>.
- [2] Rose KM, et al. Orthostatic hypotension predicts mortality in middle-aged adults. *Circulation* 2006;114:630–6. <https://doi.org/10.1161/circulationaha.105.598722>.
- [3] Avenali M, et al. Are patients with GBA-Parkinson disease good candidates for deep brain stimulation? A longitudinal multicentric study on a large Italian cohort. *J Neurol Neurosurg Psychiatry* 2024;95:309–15. <https://doi.org/10.1136/jnnp-2023-332387>.
- [4] Harkema SJLDB, Wang S, Aslan S, Angeli CA, Ovechkin A, Hirsch GA. Epidural spinal cord stimulation training and sustained recovery of cardiovascular function in individuals with chronic cervical spinal cord injury. *JAMA Neurol* 2018;75(12):1569–71. <https://doi.org/10.1001/jamaneurol.2018.2617>. Dec 1.
- [5] Squair JW, et al. Implanted system for orthostatic hypotension in multiple-system atrophy. *N Engl J Med* 2022;386:1339–44. <https://doi.org/10.1056/NEJMoa2112809>.
- [6] Postuma RB, et al. MDS clinical diagnostic criteria for Parkinson's disease. *Mov Disord* 2015;30:1591–601. <https://doi.org/10.1002/mds.26424>.
- [7] Samejima S, et al. Spinal cord stimulation prevents autonomic dysreflexia in individuals with spinal cord injury: a case series. *J Clin Med* 2023;12:2897. <https://doi.org/10.3390/jcm12082897>.

Xue Zhu^{a,1}, Yuyan Tan^{a,1}, Zhuokun Gu^{a,1}, Yuchao Yang^a,
Ningyuan Wang^a, Qianyi Yin^a, Sijia Huang^a, Zhengyu Lin^b,
Peng Huang^b, Dianyou Li^{b,*}, Andrei Krassioukov^{c,**}, Jun Liu^{a,***}

^a Department of Neurology and Institute of Neurology, Ruijin Hospital, Shanghai Jiao Tong University School of Medicine, Shanghai, China

^b Department of Neurosurgery, Center for Functional Neurosurgery, Ruijin Hospital, Shanghai Jiao Tong University School of Medicine, Shanghai, China

^c International Collaboration on Repair Discoveries, Faculty of Medicine, University of British Columbia, Vancouver, BC, Canada

* Corresponding author.

** Corresponding author.

*** Corresponding author.

E-mail addresses: ldy11483@rjh.com.cn (D. Li), andrei.krassioukov@vch.ca (A. Krassioukov), jly0520@hotmail.com (J. Liu).

¹ These authors contributed equally to this work as co-first authors.