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Stellate ganglion block combined with low-dose dexmedetomidine for refractory opioid dependence with cerebral atrophy and severe sympathetic storm after repeated detoxification failure: a case report

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Case Report

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Abstract

Background: Opioid use disorder is a chronic, relapsing condition, and a subset of patients fail repeated detoxification and develop a withdrawal syndrome dominated by sympathetic hyperactivity. We report a patient with mixed opioid dependence, cerebral atrophy and a refractory post-withdrawal sympathetic storm who was managed with stellate ganglion block combined with low-dose dexmedetomidine.

Case presentation: A 38-year-old man with dependence on nalbuphine, buprenorphine and self-administered oxycodone had failed two standardized detoxifications and relapsed promptly after each discharge. After complete drug cessation he developed persistent chest tightness, agitation, hyperhidrosis, uncontrollable anxiety, total insomnia and intense drug craving. Brain magnetic resonance imaging showed diffuse cerebral atrophy, and GAD-7, PHQ-9 and PSQI indicated severe anxiety, depression and insomnia. Conventional supportive treatment was ineffective. Staged ultrasound-guided stellate ganglion block (lidocaine 10 mg + anisodamine 2 mg, twice daily initially and then nightly) combined with low-dose intravenous dexmedetomidine (1 μg/kg) and short-term lorazepam bridging terminated the sympathetic storm, restored sleep and mood, and eliminated craving. At the second discharge, heart rate variability still showed reduced parasympathetic indices and an elevated LF/HF ratio of 6.51, whereas the orthostatic response was normal. The patient remained abstinent without relapse at the 3-month follow-up.

Conclusions: The combination of stellate ganglion block and dexmedetomidine was safe and effective in terminating a severe withdrawal sympathetic storm in this patient and supported sustained abstinence. Persisting sympathovagal imbalance at discharge indicates that autonomic recovery lags behind symptom control, and objective autonomic monitoring should be part of such management. The strategy merits evaluation in larger series.

Background

Opioid use disorder is a chronic, relapsing disease that remains a leading contributor to disability and premature death worldwide [1]. Nonmedical use of prescription opioids has risen substantially over the past two decades, and dependence on mixed mu-agonist and partial-agonist opioids, including nalbuphine, is now a common clinical presentation [2]. The disorder is sustained not only by reward-driven drug seeking but also by progressive dysregulation of brain stress systems, so that withdrawal itself becomes a powerful driver of continued use and relapse [3]. Detoxification and agonist maintenance reduce, but do not eliminate, this risk, and a considerable proportion of patients treated in conventional programs relapse within months of discharge [5].

Noradrenergic overdrive is central to the acute withdrawal syndrome. Chronic opioid exposure increases the firing of locus coeruleus noradrenergic neurons, and removal of the drug produces a surge in noradrenergic outflow that accounts for many of the autonomic features of withdrawal [4]. In severe cases these features coalesce into a sustained, storm-like hyperadrenergic state in which anxiety,

insomnia and drug craving reinforce one another, and each of these symptoms is independently associated with relapse [3, 6, 7].

Anesthetic neuromodulation offers a complementary means of interrupting this cascade. Stellate ganglion block suppresses pathological sympathetic outflow at the cervical level and is an established rescue intervention for refractory electrical storm [8]; randomized and observational data also support its use in stress-related psychiatric conditions, in which it appears to reduce hyperarousal [9, 10]. Dexmedetomidine, a highly selective α2-adrenoceptor agonist, provides central anxiolysis and sedation by inhibiting noradrenergic transmission at its source [11]. We reasoned that combining peripheral sympathetic interruption with central noradrenergic inhibition might break the withdrawal–sympathetic–craving cycle in patients who had already failed conventional treatment. Here we report a patient with mixed opioid dependence, cerebral atrophy and a severe post-withdrawal sympathetic storm who was treated successfully with staged stellate ganglion block, low-dose dexmedetomidine and short-term benzodiazepine bridging.

Case presentation

Patient information

A 38-year-old man was admitted with refractory opioid dependence, two failed detoxifications, intractable insomnia and severe withdrawal anxiety. He had a long history of heavy cigarette smoking and daily areca-nut chewing. No relevant family history was reported.

Medical history

The patient began nalbuphine for renal colic and within months developed tolerance and psychological dependence. He subsequently used buprenorphine and self-administered extended-release oxycodone, and took clonazepam orally in an attempt to relieve anxiety and sleeplessness [2, 12]. Prolonged multi-drug use was accompanied by dizziness and unsteady gait, and he sustained a traumatic fracture after a fall.

After complete cessation of nalbuphine, buprenorphine, oxycodone and clonazepam, he developed a severe withdrawal syndrome with prominent autonomic features. Two standardized detoxification treatments in specialized addiction services both failed, and he relapsed shortly after each discharge because of severe withdrawal discomfort and craving. Of note, oxycodone was never prescribed to him for insomnia, chest tightness or anxiety; all of his oxycodone use was self-initiated drug-seeking.

Withdrawal manifestations

At the current admission, after complete drug cessation, the patient presented with a persistent and severe sympathetic storm:

- recurrent chest tightness, palpitations and a sense of impending panic;
- marked irritability, agitation and uncontrollable anxiety;
- paroxysmal generalized sweating and hot flushes;
- total inability to sleep, with no sustained sleep for several consecutive nights;
- intense, unrelenting craving for opioids.

Investigations

Brain magnetic resonance imaging showed diffuse cerebral atrophy with widened sulci and shallow gyri, consistent with chronic drug-related parenchymal loss; there was no acute infarction, hemorrhage or space-occupying lesion. These findings accord with neuroimaging evidence of reduced gray-matter volume in substance use disorders and with the concept of opioid-related structural brain injury [13, 14].

Psychological assessment on admission indicated severe anxiety (GAD-7), severe depression (PHQ-9) and severe insomnia (PSQI) [15, 16, 17].

Diagnosis

The following diagnoses were established: refractory mixed opioid dependence (nalbuphine, buprenorphine, oxycodone); two failed standardized detoxifications with rapid relapse; severe withdrawal-related sympathetic storm with intractable autonomic dysfunction; severe anxiety, severe depression and severe refractory insomnia; and drug-related cerebral atrophy.

Treatment

Because the patient had organic cerebral damage, repeated treatment failure and an intractable hyperadrenergic state, a staged multimodal anesthetic protocol was used. The design was peripheral–central: stellate ganglion block was directed at excessive sympathetic outflow, and dexmedetomidine at central noradrenergic arousal.

Ultrasound-guided stellate ganglion block was performed twice daily during the first two inpatient days and once nightly thereafter. Each injection consisted of lidocaine 10 mg plus anisodamine hydrobromide 2 mg, diluted with normal saline to 6 mL [18]. The aim was to interrupt pathological sympathetic efferent discharge, terminate and prevent recurrence of sympathetic storm, and improve cerebral perfusion [8, 9, 10, 18].

Dexmedetomidine 1 μg/kg, diluted with normal saline to 100 mL, was infused intravenously once daily. Through central α2-adrenoceptor activation it produced anxiolysis and sedation without respiratory depression or an opioid-like dependence liability [11, 19, 20].

Lorazepam 1 mg twice daily was used as short-term bridging anxiolytic therapy and was tapered stepwise to avoid secondary benzodiazepine dependence [21]. Psychological support and structured behavioral management were provided throughout.

Outcome and follow-up

All components of the sympathetic storm — chest tightness, agitation and hyperhidrosis — resolved within the treatment period. Anxiety and depressed mood improved substantially, sleep normalized, and opioid craving disappeared. The patient was discharged fully abstinent without withdrawal rebound.

At one and three months of outpatient follow-up, sleep and mood remained stable, and there was no drug craving, relapse or recurrence of autonomic symptoms.

Autonomic function testing

Because autonomic dysfunction was central to the clinical picture, cardiovascular autonomic function was assessed on 23 October 2026, shortly before the second discharge, with an ECG-based automated test battery that included deep-breathing, Valsalva and orthostatic tests together with time-domain and spectral heart rate variability (HRV) analysis (Fig. 1; Table 1). The deep-breathing test was abnormal, indicating impaired cardiac vagal modulation, and the Valsalva response was borderline. Time-domain indices of vagal activity were low (rMSSD 23 ms; pNN50 2%), and spectral analysis showed a markedly elevated low-frequency/high-frequency (LF/HF) ratio of 6.51 (LF 670.56 ms^2; HF 102.93 ms^2), consistent with sympathetic predominance [22, 23, 24]. By contrast, the orthostatic response was normal: systolic blood pressure fell by at most 7 mmHg on standing, and the RR30/15 ratio was 0.93, indicating preserved dynamic cardiovascular adaptation.

Table 1
Heart rate variability and orthostatic parameters at the second discharge (23 October 2026)

Parameter	Value
Mean heart rate (bpm)	62 (range 54–72)
SDNN (ms)	67
rMSSD (ms)	23
pNN50 (%)	2
VLF power (ms²)	3368.81
LF power (ms²)	670.56
HF power (ms²)	102.93
Total power (ms²)	4142.30
LF/HF ratio	6.51
RR30/15 ratio	0.93
Baroreflex sensitivity (as reported)	−2.90
Supine blood pressure (mmHg)	138/82
Standing blood pressure at 3–10 min (mmHg)	132/87
Maximum orthostatic systolic fall (mmHg)	7

Values are as reported by the automated test battery.

Discussion and conclusions

The clinical course of this patient separates two components of severe opioid withdrawal that are often conflated. The acute sympathetic storm was terminated within days of starting combined therapy and did not return after treatment was stopped. Yet HRV obtained at the second discharge still showed attenuated vagal indices and an elevated LF/HF ratio — a resting sympathovagal imbalance that outlasted the storm. Reduced vagal tone and sympathetic predominance have been described in opioid-dependent patients, and recovery of these measures is slow [23, 24]; similar changes are present in chronic insomnia, which this patient also had [25]. Two practical points follow. Symptomatic remission can precede autonomic normalization, and objective autonomic monitoring may therefore be more informative than symptom report for judging residual dysregulation and for timing the withdrawal of neuromodulatory treatment [22, 23]. The persistence of imbalance is also consistent with the view that drug-related autonomic remodeling, like the structural changes on MRI, requires longer-term rehabilitation [13, 14].

The treatment was designed around two complementary targets. Stellate ganglion block interrupts sympathetic efferent traffic to the head, neck, heart and upper trunk; its documented ability to terminate refractory electrical storm provides proof of concept that cervical sympathetic blockade can break a self-perpetuating hyperadrenergic state [8]. Randomized evidence in posttraumatic stress disorder suggests that the same intervention reduces hyperarousal symptoms [9, 26], and a systematic review supports its use across several psychiatric conditions [10]. Anisodamine was added for its anticholinergic and vasoregulatory actions, which may further modulate excessive autonomic tone and support perfusion [18].

Dexmedetomidine acts at central α2-adrenoceptors to reduce noradrenergic outflow, yielding anxiolysis and sedation without respiratory depression or dependence liability [11, 19]. Reports of its use to facilitate opioid and benzodiazepine withdrawal in critically ill and postoperative patients support this indication [19, 20]. In the present patient it was given in low dose as a daily infusion, and the combined regimen was delivered without interruption over the inpatient period. Lorazepam was strictly transitional; short-term benzodiazepine bridging with planned tapering is the strategy recommended to avoid a second dependence [21].

These interventions do not replace established care. Agonist maintenance with methadone or buprenorphine remains the best-evidenced treatment for opioid dependence [5, 27], and α2-adrenergic agonists such as clonidine and lofexidine are recommended adjuncts during withdrawal [28]. The role proposed here is narrower: for patients who fail repeated detoxification and enter a storm-like hyperadrenergic state, anesthetic neuromodulation may offer a rescue pathway that directly addresses the autonomic component [8, 9, 26].

Several limitations should be acknowledged. This is a single case, and the favorable outcome may in part reflect the natural course of withdrawal. We did not obtain baseline HRV before treatment, so the contribution of the intervention to the observed autonomic state cannot be quantified, and a single post-treatment measurement limits any inference about residual imbalance. LF/HF is an imperfect index of sympathovagal balance and should be interpreted with caution [22]. Scales were not re-scored formally at discharge, and follow-up was limited to three months. Finally, the regimen combined three interventions, so the contribution of each cannot be separated.

In a patient with refractory mixed opioid dependence, cerebral atrophy and a severe withdrawal sympathetic storm after two failed detoxifications, staged ultrasound-guided stellate ganglion block combined with low-dose dexmedetomidine and short-term benzodiazepine bridging terminated the storm, restored sleep and mood, and supported sustained abstinence. The persistence of sympathovagal imbalance on HRV at discharge indicates that autonomic recovery lags behind symptom control and argues for objective autonomic monitoring during such treatment. The strategy merits prospective evaluation in larger series.

Abbreviations

GAD-7	Generalized Anxiety Disorder-7
HF	high frequency
HRV	heart rate variability
LF	low frequency
LF/HF	low-frequency/high-frequency ratio
MRI	magnetic resonance imaging
pNN50	proportion of successive RR intervals differing by more than 50 ms
PHQ-9	Patient Health Questionnaire-9
PSQI	Pittsburgh Sleep Quality Index
rMSSD	root mean square of successive differences between normal heartbeats
SDNN	standard deviation of NN intervals
SGB	stellate ganglion block
VLF	very low frequency

Declarations

Ethics approval and consent to participate:

This case report was conducted in accordance with the Declaration of Helsinki. Ethical approval was waived by the institutional review board of Cangzhou Central Hospital (waiver number [XX]) because this is a retrospective report of routine clinical care of a single patient. Written informed consent was obtained from the patient.

Consent for publication:

Written informed consent for publication was obtained from the patient. All identifying details were anonymized.

Competing interests:

The authors declare that they have no competing interests.

Authors' contributions

XJ designed the treatment protocol and drafted the manuscript; [Initials] performed the stellate ganglion blocks and clinical care; [Initials] performed and interpreted the autonomic function testing. All authors

read and approved the final manuscript.

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Author Contribution

Author contributionsJi Xiaochen: Conceptualization, case data collection, investigation, writing – original draft.Sun Wenbo: Methodology, formal analysis, supervision, writing – review & editing.Conflict of interestThe authors declare that they have no competing interests

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Availability of data and materials:

The data supporting the findings of this case report are available from the corresponding author on reasonable request.

References

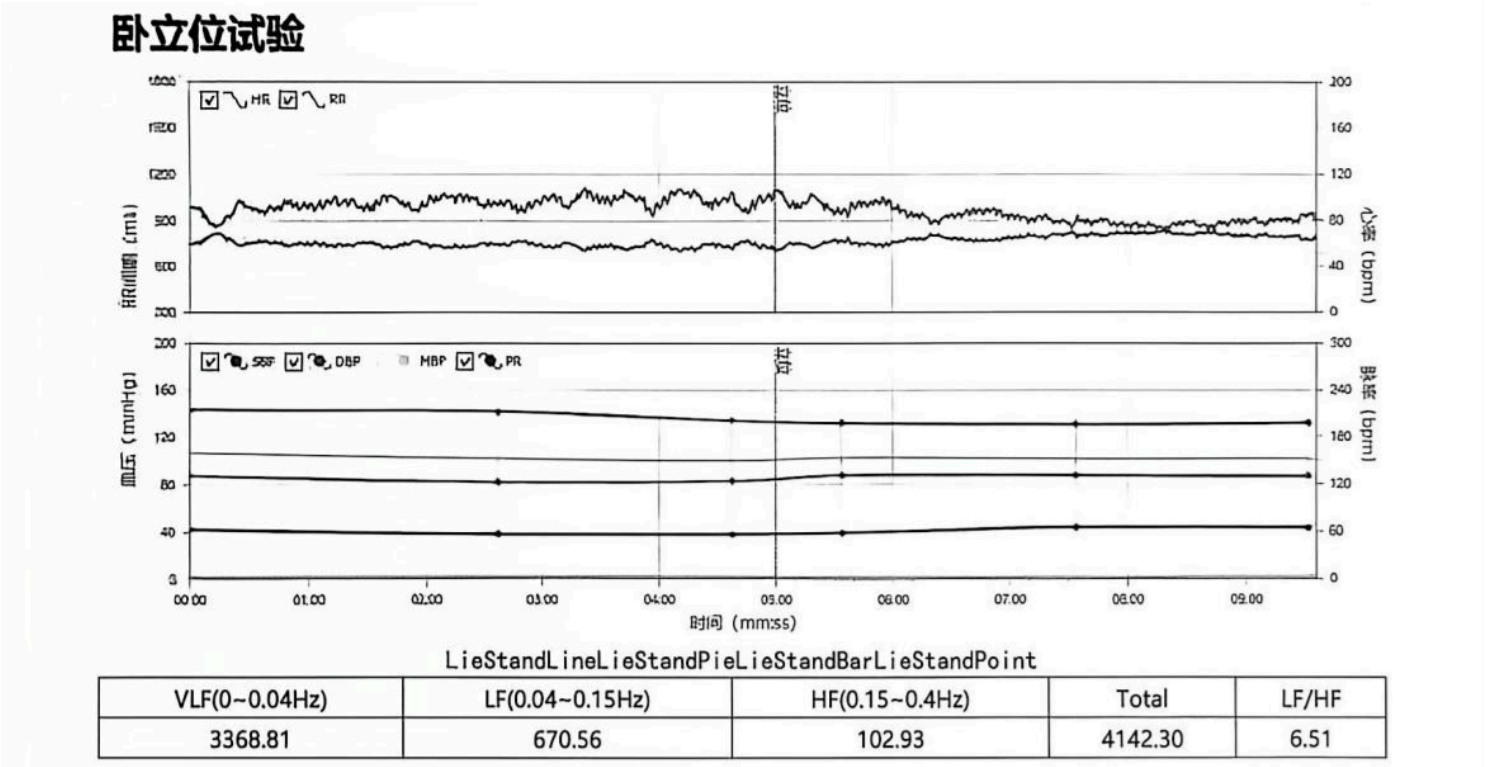
1. Strang J, Volkow ND, Degenhardt L, Hickman M, Johnson K, Koob GF, Marshall BDL, Tyndall M, Walsh SL. Opioid use disorder. Nat Rev Dis Primers. 2020;6(1):3.
2. Compton WM, Volkow ND. Major increases in opioid analgesic abuse in the United States: concerns and strategies. Drug Alcohol Depend. 2006;81(2):103–7.
3. Koob GF, Volkow ND. Neurobiology of addiction: a neurocircuitry analysis. Lancet Psychiatry. 2016;3(8):760–73.
4. Gold MS, Kleber HD. A rationale for opiate withdrawal symptomatology. Drug Alcohol Depend. 1979;4(5–6):419–24.
5. Volkow ND, Jones EB, Einstein EB, Wargo EM. Prevention and treatment of opioid misuse and addiction: a review. JAMA Psychiatry. 2019;76(2):208–16.
6. Sinha R. The clinical neurobiology of drug craving. Curr Opin Neurobiol. 2013;23(4):649–54.
7. Angarita GA, Emadi N, Hodges S, Morgan PT. Sleep abnormalities associated with alcohol, cannabis, cocaine, and opiate use: a comprehensive review. Addict Sci Clin Pract. 2016;11:9.
8. Meng L, Tseng CH, Shivkumar K, Ajijola OA. Efficacy of stellate ganglion blockade in managing electrical storm: a systematic review. JACC Clin Electrophysiol. 2018;4(7):942–9.

9. Hanling SR, Hickey A, Lesnik I, Hackworth RJ, Stedje-Larsen E, Drastal CA, McLay RN. Stellate ganglion block for the treatment of posttraumatic stress disorder: a randomized, double-blind, controlled trial. Reg Anesth Pain Med. 2016;41(4):494–500.
10. Kerzner J, Liu H, Demchenko I, Sussman D, Wijeysundera DN, Kennedy SH, Ladha KS, Bhat V. Stellate ganglion block for psychiatric disorders: a systematic review of the clinical research landscape. Chronic Stress. 2022;6:24705470221081731.
11. Weerink MAS, Struys MMRF, Hannivoort LN, Barends CRM, Absalom AR, Colin P. Clinical pharmacokinetics and pharmacodynamics of dexmedetomidine. Clin Pharmacokinet. 2017;56(8):893–913.
12. Peachey JE. Clinical observations of agonist-antagonist analgesic dependence. Drug Alcohol Depend. 1987;20(4):347–65.
13. Pando-Naude V, Toxto S, Fernandez-Lozano S, Parsons CE, Alcauter S, Garza-Villarreal EA. Gray and white matter morphology in substance use disorders: a neuroimaging systematic review and meta-analysis. Transl Psychiatry. 2021;11(1):29.
14. Herlinger K, Lingford-Hughes A. Opioid use disorder and the brain: a clinical perspective. Addiction. 2022;117(2):495–505.
15. Spitzer RL, Kroenke K, Williams JBW, Löwe B. A brief measure for assessing generalized anxiety disorder: the GAD-7. Arch Intern Med. 2006;166(10):1092–7.
16. Kroenke K, Spitzer RL, Williams JBW. The PHQ-9: validity of a brief depression severity measure. J Gen Intern Med. 2001;16(9):606–13.
17. Buysse DJ, Reynolds CF 3rd, Monk TH, Berman SR, Kupfer DJ. The Pittsburgh Sleep Quality Index: a new instrument for psychiatric practice and research. Psychiatry Res. 1989;28(2):193–213.
18. Poupko JM, Baskin SI, Moore E. The pharmacological properties of anisodamine. J Appl Toxicol. 2007;27(2):116–21.
19. Maccioli GA. Dexmedetomidine to facilitate drug withdrawal. Anesthesiology. 2003;98(2):575–7.
20. Finkel JC, Elrefai A. The use of dexmedetomidine to facilitate opioid and benzodiazepine detoxification in an infant. Anesth Analg. 2004;98(6):1658–9.
21. Oude Voshaar RC, Couvée JE, van Balkom AJLM, Mulder PGH, Zitman FG. Strategies for discontinuing long-term benzodiazepine use: meta-analysis. Br J Psychiatry. 2006;189:213–20.
22. Task Force of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology. Heart rate variability: standards of measurement, physiological interpretation, and clinical use. Eur Heart J. 1996;17(3):354–81.
23. Chang LR, Lin YH, Kuo TBJ, Ho YC, Chen SH, Wu Chang HC, Liu CM, Yang CCH. Cardiac autonomic modulation during methadone therapy among heroin users: a pilot study. Prog Neuropsychopharmacol Biol Psychiatry. 2012;36(2):258–61.
24. Huang WL, Lin YH, Kuo TBJ, Chang LR, Chen YZ, Yang CCH. Methadone-mediated autonomic functioning of male patients with heroin dependence: the influence of borderline personality pattern.

PLoS ONE. 2012;7(5):e37464.

25. Bonnet MH, Arand DL. Heart rate variability in insomniacs and matched normal sleepers. Psychosom Med. 1998;60(5):610–5.
26. Rae Olmsted KL, Bartoszek M, Mulvaney S, McLean B, Turabi A, Young R, Kim E, Vandermaas-Peeler R, Morgan JK, Constantinescu O, Kane S, Nguyen C, Hirsch S, Muñoz B, Wallace D, Croxford J, Lynch JH, White R, Walters BB. Effect of stellate ganglion block treatment on posttraumatic stress disorder symptoms: a randomized clinical trial. JAMA Psychiatry. 2020;77(2):130–8.
27. Mattick RP, Breen C, Kimber J, Davoli M. Buprenorphine maintenance versus placebo or methadone maintenance for opioid dependence. Cochrane Database Syst Rev. 2014;(2):CD002207.
28. Gowing L, Farrell M, Ali R, White JM. Alpha2-adrenergic agonists for the management of opioid withdrawal. Cochrane Database Syst Rev. 2016;(5):CD002024.

Figures



VLF(0~0.04Hz)	LF(0.04~0.15Hz)	HF(0.15~0.4Hz)	Total	LF/HF
3368.81	670.56	102.93	4142.30	6.51

Figure 1

Cardiovascular autonomic function report obtained on 23 October 2026, shortly before the second discharge. The deep-breathing test was abnormal (impaired cardiac vagal modulation) and the Valsalva response was borderline; heart rate variability showed low vagal indices and an elevated LF/HF ratio (6.51). The orthostatic response was normal.