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Temporary Phrenic Nerve Peripheral Nerve Stimulation for Intractable Hiccups: A Case Report

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Background: Intractable hiccups (IH), defined as symptoms lasting longer than one month, can lead to significant morbidity and often fail to respond to standard medical and interventional therapies. Peripheral nerve stimulation (PNS) of the phrenic nerve represents a novel, mechanism-based treatment approach targeting the efferent limb of the hiccup reflex arc.

Case Report: A 50-year-old man with a 3-year history of IH refractory to multiple medications and an external vagus nerve stimulator underwent a left phrenic nerve PNS trial. During the 60-day trial, hiccup episodes decreased from 10-15 days to 2 days, with prolonged symptom-free intervals. Following lead explant, the patient experienced shorter, more predictable episodes. Given the response, a subsequent contralateral (right-sided) phrenic nerve PNS trial was performed, resulting in a symptom-free interval of 15 days, the longest symptom-free interval reported by the patient.

Conclusions: Phrenic nerve PNS may offer a safe, minimally invasive reversible option for patients with refractory IH when conventional therapies fail.

Key words: Intractable hiccups, peripheral nerve stimulation, phrenic nerve, neuromodulation

BACKGROUND

Hiccups are involuntary, spasmodic contractions of the diaphragm and intercostal muscles followed by abrupt glottic closure. This produces the characteristic inspiratory "hic" sound. Most episodes are transient and benign, resolving within 48 hours without treatment. Hiccups affect approximately 0.05% of general inpatients and up to 10% of patients with gastroesophageal reflux disease (1). When symptoms persist beyond 48 hours, they are termed persistent hiccups. Intractable hiccups (IH) are diagnosed if they exceed one month in duration. Though uncommon and considered a rare condition, precise population-level incidence data for IH remain poorly defined. IH can cause profound morbidity, including malnutrition, dehydration, insomnia, aspiration, psychosocial distress, and is notoriously difficult to treat (2,3).

The hiccup reflex arc includes afferent input from the phrenic, vagus, and sympathetic nerves (T6-T12), with central integration within the medullary reticular formation, nucleus tractus solitarius, and hypothalamic regions. The efferent output occurs via the phrenic nerve to the diaphragm and intercostal musculature (4-6). Disruption or irritation at any level of this reflex arc, whether due to central lesions, peripheral irritation, metabolic derangements, or medications, can bring about hiccups (4,6).

First-line management involves addressing any

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potential underlying reversible etiologies and employing pharmacologic modulation of dopaminergic and γ-aminobutyric acid pathways. Agents, such as baclofen, gabapentin, chlorpromazine, and metoclopramide, are most frequently employed; however, evidence for these therapies remains limited to case reports and small series (3-5,7). In a systematic review, Steger et al (6) reported that pharmacotherapy is inconsistently effective, and treatment-resistant cases are common. For patients unresponsive to medication, interventional strategies have been attempted whereby different components of the hiccup reflex arc have been targeted. Stellate ganglion blocks (SGBs) have been shown to transiently suppress symptoms through modulation of sympathetic tone (8,9), while vagus nerve stimulation (VNS) has provided benefit in select refractory cases (10,11). More recently, phrenic nerve blocks performed under ultrasound proved effective in terminating postoperative or idiopathic IH, highlighting the phrenic nerve's pivotal role in hiccup generation (12,13).

Peripheral nerve stimulation (PNS) represents a minimally invasive and reversible neuromodulatory technique capable of targeting the peripheral nerves implicated in hiccup reflex dysfunction. While traditionally utilized for neuropathic pain, emerging evidence suggests utility in autonomic and visceral disorders. The phrenic nerve, as the principal efferent limb of the hiccup reflex, is a novel target for PNS. To our knowledge, phrenic nerve PNS has only recently been described once in the literature, a 2025 case report by Jevotovsky et al (14). They described the use of bilateral phrenic nerve PNS (right side placed first followed by the left side one month later) for a 60-day trial. They reported reduced hiccup severity and speech improvement compared with his abilities before the PNS trial at 4 month follow-up (14).

The 2022 American Society of Pain and Neuroscience (ASPN) and 2024 American Society of Interventional Pain Physicians (ASIPP) guidelines now acknowledge PNS as an evidence-supported option for peripheral and autonomic neuromodulation (15,16). Given the debilitating nature of IH and the paucity of effective therapies, targeted neuromodulation of the phrenic nerve represents a promising therapeutic frontier. We present, to our knowledge, the second case of phrenic nerve PNS following failure of extensive pharmacologic and interventional therapy, illustrating its potential efficacy and clinical durability.

CASE PRESENTATION

A 50-year-old man with a history of malnutrition, cerebellar ataxia, gastroesophageal reflux disease, dysphonia, chronic hyponatremia, and prior military exposure to potentially hazardous substances was referred for evaluation and management of a 3-year history of IH. The episodes were cyclical and distressing, lasting up to 15 days at a time with a baseline intensity of 5 out of 10 and frequent nocturnal exacerbations. They were occasionally triggered by laughter and associated with reflux symptoms, but had no consistent alleviating factors. The condition was further complicated by presumed multiple system atrophy with orthostatic hypotension. There was no evidence of diaphragmatic weakness or pulmonary pathology on imaging.

The condition proved refractory to multiple pharmacologic therapies. High-dose gabapentin produced a reduction in frequency and severity, but was limited by gait instability and cognitive fog. A trial of domperidone, in 2024, provided uncertain benefit, and the patient continued to use gabapentin 600 mg as needed for breakthrough spells, which offered only transient relief. Levetiracetam 250 mg twice daily caused sedation and was discontinued. A trial of metoclopramide was also ineffective. An external VNS trial was subsequently attempted without meaningful improvement. We discussed and decided against phrenic nerve blockade given the short-term relief in the literature as well as baseline obstructive sleep apnea and multisystem atrophy and possible respiratory effects.

Given the chronicity of symptoms and suspected autonomic contribution, sequential right and left SGBs were performed one week apart. The patient experienced modest improvement, including a 9-day symptom-free interval following the left-sided block and a noticeable reduction in hiccup frequency and duration overall. The partial, but reproducible, benefit prompted further exploration of neuromodulatory targets within the hiccup reflex arc, including the phrenic nerve, which carries major efferent input to the diaphragm.

A temporary left phrenic nerve PNS, using the SPRINT® system (SPR Therapeutics, Cleveland, OH), was placed. The patient was positioned supine and prepped in a sterile fashion. A 15-4 MHz linear transducer was used to identify the left anterior and middle scalene muscles, brachial plexus, and phrenic nerve. Using an in-plane approach, a 19G stimulating probe was advanced through a 17G percutaneous sleeve close to the phrenic nerve (Fig. 1). Test stimulation produced comfortable

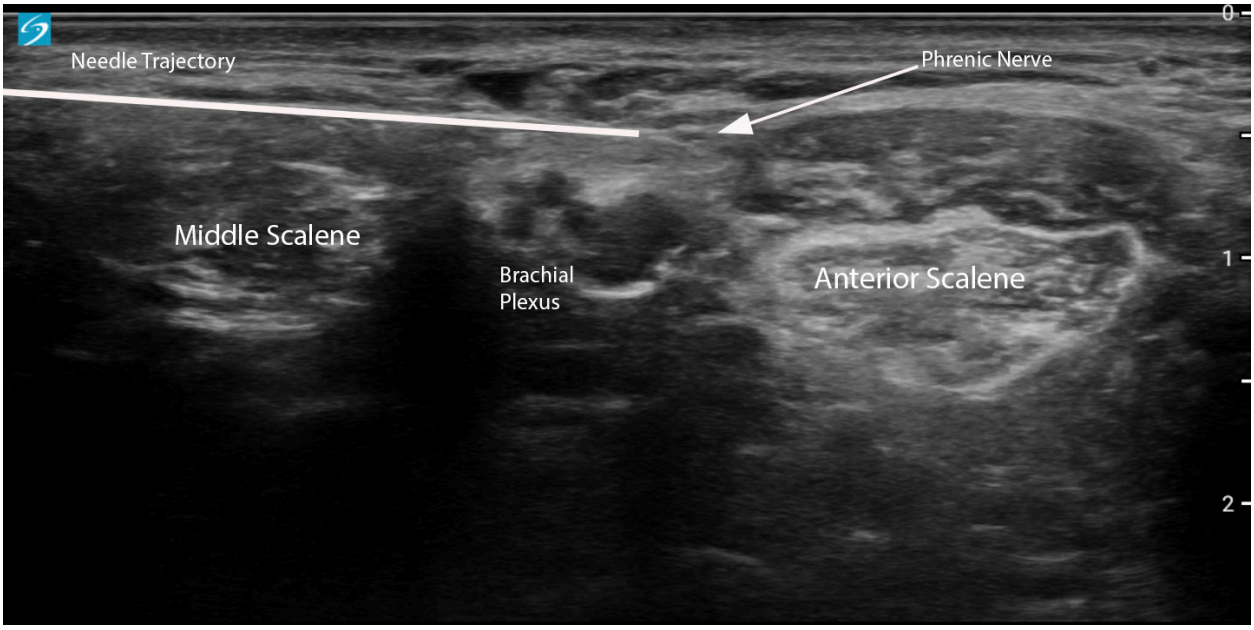

Fig. 1. Ultrasound image demonstrating in-plane needle advancement toward the left phrenic nerve for temporary peripheral nerve stimulation lead placement. The anterior scalene, middle scalene, brachial plexus, and phrenic nerve are identified.

paresthesia over the neck and chest. The probe was exchanged for a 20G microlead introducer containing the PNS lead, and proper stimulation coverage was reconfirmed. The introducer-sleeve assembly was withdrawn with manual traction to deploy the distal anchor close to the phrenic nerve. Final programming consisted of a single-lead 100-Hz continuous stimulation, 24 hours per day, for the full 60-day trial. No intraprocedural complications were noted, nor infection or local skin irritation for the lead or lead-securing system. The external pulse generator was placed on his left posterior shoulder.

At his first follow-up, day 14/60 after trial lead implantation, the patient reported near-complete cessation of hiccups for up to one week at a time. Over the 60-day trial period, episode duration decreased from 10-15 days to approximately 2 days, representing the most substantial and durable improvement after years of failed medical and procedural therapy. The patient and his spouse expressed apprehension regarding lead removal at the end of the 60-day trial given the substantial benefit. At his 30-day postexplant visit (90 days since the trial lead was placed), he maintained a symptom diary documenting shorter, more predictable, primarily nocturnal episodes without adverse effects or identifiable triggers. Both the patient and his spouse described significant relief at his follow-up, leading him to express interest in an additional procedure. He elected to undergo a contralateral phrenic nerve PNS trial to evaluate potential additive benefit. At his most recent follow-up, day 42/60, after placement of the right-sided phrenic nerve PNS trial lead, he had been hiccup free for 15 days, which is the longest stretch ever. We discussed permanent implantation in the future, but given his frequent need for screening magnetic resonance imaging (MRI), the systems available within our hospital system are not MRI compatible.

The patient was informed of the procedure's investigational nature, potential risks, benefits, and alternatives. Written and signed informed consent was obtained for publication of this report.

CONCLUSIONS

Meaningful control of IH remains elusive due to their multifactorial etiology, poorly defined neurophysiologic mechanisms and targets, and lack of consistently effective treatments. Conventional pharmacologic therapies, although commonly employed, are largely supported by low-level evidence and frequently fail to achieve durable remission (4-6). The patient in this case demonstrated classic treatment resistance, with minimal or transient improvement from gabapentin, domperidone, levetiracetam, and metoclopramide. Such cases

underscore the need for targeted, mechanism-based interventions beyond traditional pharmacotherapy.

Interventional strategies, including SGB and VNS, have shown variable success in interrupting afferent and central components of the hiccup reflex arc (8-11). SGB may attenuate hiccups through sympathetic modulation of thoracic afferents and brainstem autonomic centers, while VNS exerts both afferent inhibitory and central neuromodulatory effects on the nucleus tractus solitarius. However, outcomes across published reports remain inconsistent, and benefits are often transient or partial. The phrenic nerve represents the final common efferent pathway in the hiccup reflex, transmitting rhythmic diaphragmatic discharges that culminate in hiccup generation (4-6,12,13). Blockade or modulation of this nerve offers a direct means of suppressing the motor output responsible for hiccup generation. Several reports (12,13) have described temporary cessation of hiccups following phrenic nerve block under ultrasound. Building on this rationale, PNS of the phrenic nerve offers a minimally invasive, reversible approach capable of providing sustained inhibitory modulation without permanent denervation or diaphragmatic paralysis.

In this case, we elected to utilize a 60-day temporary phrenic nerve PNS for potentially substantial and durable symptomatic improvement after years of pharmacologic and procedural therapy failure. This patient's marked reduction in episode frequency and duration suggests that PNS may facilitate neuromodulatory reconditioning within the hiccup reflex arc rather than functioning solely as an efferent blockade. Similar durable benefit was reported by Jevotovsky et al (14), who described reduction of chronic IH using phrenic nerve stimulation after failed medical management. Collectively, these findings suggest a potential central plasticity effect analogous to that proposed for other PNS applications targeting visceral and autonomic modulation (15,16).

The precise mechanism by which phrenic nerve stimulation suppresses hiccups remains speculative. Proposed pathways include modulation of efferent diaphragmatic excitability, normalization of afferent sensory feedback to the medullary respiratory centers, and potential inhibitory effects on the nucleus tractus solitarius. Peripheral reconditioning of central reflex circuits, as described in the 2022 ASPN and 2024 ASIPP guidelines, may contribute to sustained benefit beyond the stimulation period (15,16). From a procedural standpoint, temporary PNS systems, such as the SPRINT device, offer a low-risk means of assessing neuromodulatory efficacy in visceral and autonomic or reflex disorders prior to consideration of permanent implantation if necessary. Given the lack of definitive therapy and the desire to avoid permanent denervation, the temporary nature of the PNS lead, coupled with ultrasound guidance, makes this approach particularly suitable for patients with conditions, such as IH. In this case, as in the Jevotovsky et al (14) case, there were no complications procedurally or for the duration of the trial, and patients report meaningful improvement in symptom burden and quality of life. Given the morbidity of IH, clinicians may consider phrenic nerve PNS in patients with IH who fail multiple pharmacologic and interventional therapies. The limitations of the case report include the anecdotal nature of case-based evidence, absence of standardized stimulation parameters, and potential for spontaneous symptom fluctuation. Controlled studies are necessary to validate efficacy, define candidate selection criteria, and elucidate standardization of lead placement and stimulation protocols. Future research should also explore the comparative role of phrenic nerve PNS relative to other neuromodulatory interventions targeting central or autonomic pathways established in the hiccup reflex arc.

Our case demonstrates meaningful and durable symptom reduction following failure of conventional pharmacological and interventional therapies with phrenic nerve PNS. Further controlled studies are warranted to validate efficacy, standardize procedural parameters, and define the role of phrenic nerve PNS within the broader framework of therapeutic alternatives for IH.

REFERENCES

1. He J, Guan A, Yang T, et al. Pathogenesis and treatment of perioperative hiccups: A narrative review. *Ann Med* 2025; 57:2474173.
2. Chang FY, Lu CL. Hiccup: Mystery, nature and treatment. *J Neurogastroenterol Motil* 2012; 18:123-130.
3. Moretto EN, Wee B, Wiffen PJ, Murchison AG. Interventions for treating persistent and intractable hiccups in adults. *Cochrane Database Syst Rev* 2013; 2013:CD008768.
4. Bhatti JM, Sheikh AS, Fatima M, Khan S, Groenewald CA, Groenewald ES. Treatment approaches for persistent and intractable hiccups: A systematic review and recommendations. *J Popul Ther Clin Pharmacol* 2024; 31:1757-1767.
5. Kolodzik PW, Filers MA. Hiccups (singultus): Review and approach to management. *Ann Emerg Med* 1991; 20:565-573.
6. Steger M, Schneemann M, Fox M. Systemic review: The pathogenesis and pharmacological treatment of hiccups. *Aliment Pharmacol Ther* 2015; 42:1037-1050.
7. Mirijello A, Addolorato G, D'Angelo C, et al. Baclofen in the treatment of persistent hiccup: A case series. *Int J Clin Pract* 2013; 67:918-921.
8. Lee AR, Cho YW, Lee JM, Shin YJ, Han IS, Lee HK. Treatment of persistent postoperative hiccups with stellate ganglion block: Three case reports. *Medicine (Baltimore)* 2018; 97:e13370.
9. Lopez DJ, Kumar S. Stellate ganglion block for intractable hiccups secondary to a motor vehicle collision. *Cureus* 2023; 15:e37030.
10. Suliman A, Paranathala MP, Kolapo A, Nath U, Hussain MA. Vagal nerve stimulation for intractable hiccups. *J Neurol Res* 2024; 14:86-89.
11. Tariq K, Das JM, Monaghan S, Miserocchi A, McEvoy A. A case report of vagus nerve stimulation for intractable hiccups. *Int J Surg Case Rep* 2021; 78:219-222.
12. Ke X, Wu Y, Zheng H. Successful termination of persistent hiccups via combined ultrasound and nerve stimulator-guided singular phrenic nerve block: A case report and literature review. *J Int Med Res* 2023; 51:03000605231216616.
13. Zhong Y, Deng J, Wang L, Zhang Y. Phrenic nerve block combined with stellate ganglion block for postoperative intractable hiccups: A case report. *J Int Med Res* 2023; 51:03000605231197069.
14. Jevotovsky DS, Suarez M, Chopra H, Marascalchi BJ. Peripheral nerve stimulation (PNS) of the phrenic nerve for intractable hiccups: A novel use case report. *Reg Anesth Pain Med* 2025; 50:916-918.
15. Manchikanti L, Sanapati MR, Soin A, et al. Comprehensive evidence-based guidelines for implantable peripheral nerve stimulation (PNS) in the management of chronic pain: From the American Society of Interventional Pain Physicians (ASIPP). *Pain Physician* 2024; 27(suppl 9):S115-S191.
16. Strand N, D'Souza RS, Hagedorn JM, et al. Evidence-Based clinical guidelines from the American Society of Pain and Neuroscience for the use of implantable peripheral nerve stimulation in the treatment of chronic pain. *J Pain Res* 2022; 15:2483-2504.