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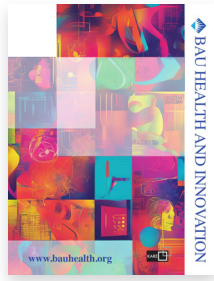

Case Report

Transcutaneous Auricular Vagus Nerve Stimulation in Trigeminal Neuralgia: A Case Report

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Abstract

Trigeminal neuralgia is a chronic pain syndrome characterized by sharp and sudden pain on one side of the face, which negatively affects patients' quality of life. Painkillers and surgical procedures such as nerve blockage are preferred in the treatment, but it requires the application of neuromodulation methods due to its side effects and controversial efficacy. In this current report, we describe a 55-year-old female patient who has been experiencing pain due to trigeminal neuralgia for about 20 years. This case highlights the effectiveness of transcutaneous auricular vagus nerve stimulation (taVNS), one of the neuromodulation methods, on pain. It is emphasized that taVNS is an effective neuromodulation method for the suppression of pain symptoms and an important modality for improving the quality of life of patients.

Keywords: Chronic pain, trigeminal neuralgia, vagus nerve stimulation.

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Trigeminal neuralgia is a recurrent neuropathic pain disorder characterized by sudden and severe attacks of pain on one side of the face related to involvement of the trigeminal nerve.[1] Pain, which can occur when chewing or speaking, has a significant impact on patients' quality of life. Current treatment options for patients with trigeminal neuralgia include pharmacological treatments, surgery, and nerve blocks. However, each of these methods has different side effects and limitations.[2]

In recent years, neuromodulation techniques such as vagus nerve stimulation (VNS) have shown promising results in the treatment of chronic pain disorders.[3] The vagus nerve plays a central role in pain regulation by modulating brainstem and limbic circuits. Transcutaneous auricular VNS (taVNS), a non-invasive method, targets the auricular branch of the vagus nerve via electrodes placed on the ear, particularly on the tragus and conchae.[4]

Anatomical studies have demonstrated that the auricle is innervated not only by the vagus nerve but also by branches of the trigeminal nerve. This overlapping innervation creates a neuroanatomical basis for possible interactions between vagus and trigeminal inputs within the brainstem nuclei, including the spinal trigeminal nucleus and the nucleus tractus solitarius.[5] This convergence suggests that VNS may indirectly influence trigeminal nociceptive processing, which could be relevant for conditions such as trigeminal neuralgia.[6]

The present case report aimed to evaluate the clinical effects of taVNS in a patient diagnosed with trigeminal neuralgia who was resistant to conventional treatment

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approaches. By illustrating the clinical outcomes of this non-invasive neuromodulation technique, we aim to contribute to the growing body of literature supporting taVNS as a potential adjunct therapy in the management of neuropathic facial pain.

Case Report

This case report included a 55-year-old female with a diagnosis of trigeminal neuralgia and facial pain symptoms for about 20 years. The physical characteristics of this patient were height 150 cm, weight 46 kg, and body mass index 20.4 kg/m^2. This patient described her pain attacks as 3–5 days a week, lasting 1–2 min. The patient described the location of the pain in the left side of the throat and ear, and complained of pain that woke her up from sleep. No etiological cause of trigeminal neuralgia was found in previous examinations. The patient had previously undergone surgery for the left trigeminal nerve block. After the surgery, her pain partially decreased, but her complaints persisted. Oxcarbazepine 600 mg/day and pregabalin 300 mg/day were reported as the medications used. The patient had no other chronic disease other than trigeminal neuralgia. Physical examination revealed tenderness on palpation in the masseter and temporalis muscles and cervical paravertebral muscles on the left side. In addition, no other pathological findings were found. Initially, the patient's pulse rate was 70/min, systolic blood pressure was 110 mmHg, and diastolic blood pressure was 75 mmHg.

When the patient was invited to the physical therapy clinic for pain relief, the physiatrist planned a total of three sessions of taVNS with one session/week. taVNS intervention was performed with the Vagustim (Copyright Vagustim, 2023, Vagustim Health Technologies, San Francisco, CA) device. The current parameters were such as: frequency-10 Hertz and pulse width-300 μs, intervention time: first session 20 min, second session 30 min, and third session 45 min. Stimulation was delivered via the tragus and concha using bilateral superficial electrodes in the ear. As these areas are very close to the trigeminal nerve, the first three sessions were performed once a week, and the application time was gradually increased. The procedure to be applied to the patient was explained, and an informed consent form was obtained. At the end of the third session, the patient's discomfort decreased, no side effects were observed, and it was recommended to continue the treatment at home for 20 min a day.

Visual Analog Scale (VAS), short form 36 (SF-36), and neuropathic pain impact on quality of life questionnaire (NePIQoL) were administered to assess treatment efficacy and pain intensity at baseline and after treatment. The change in pain experienced by the patient was observed using a scale of 0–10 on the VAS. Zero indicates no pain, whereas a score of 10 indicates the worst possible pain. The SF-36 measures general health and quality of life. This form assesses eight different health domains, such as physical functioning, social functioning, emotional state, and general health perceptions. It is widely used in clinical research and health services to monitor patients' responses to treatment and changes in their health status. NePIQoL is used to measure the impact of neuropathic pain on quality of life. This scale has 42 items. Rather than giving a single total score, the scale gives a total score for each subscale separately. The subscales assess health on a scale of 0–100, where 0 indicates poor health and 100 indicates good health.[7–9]

The changes in the patient's VAS, SF36, and NePIQoL scales at baseline and after taVNS are shown in Table 1.

There were improvements in each parameter that had a positive impact on the patient's life compared to baseline.

Discussion

The current case report demonstrated significant improvements in pain perception, facial muscle tenderness, and quality of life following a structured 3-week taVNS protocol. These outcomes were supported by improvements in VAS, SF-36, and NePIQoL domains.

taVNS contributed to a marked reduction in pain symptoms associated with trigeminal neuralgia. Administered once weekly over a 3-week period, the intervention resulted in measurable improvements in pain intensity and disability. Notably, the therapeutic gains were sustained over a 10-day follow-up period with continued home-based stimulation, indicating a potential for prolonged efficacy.

The existing literature supports the efficacy of taVNS in chronic pain conditions. Several studies have highlighted its ability to modulate central pain processing and enhance parasympathetic activity.[3,10–12] These effects are mediated through the nucleus tractus solitarius and associated brainstem circuits, which play critical roles in pain regulation.[13] The findings in our case are consistent with such mechanisms, as the patient exhibited clinically significant improvements in both pain perception and functional capacity.

Oshinsky et al.[12] investigated the role of VNS in managing trigeminal allodynia and reported significant reductions in periorbital sensitivity following a brief stimulation period in animal models. Importantly, they also demonstrated a decrease in glutamate concentrations within the trigeminal nucleus caudalis.[11] Among the proposed mechanisms underlying taVNS, glutamate modulation has received consistent empirical support. Early morphological studies

Table 1. Percentage changes in VAS, SF36, and NePIQoL scale scores after taVNS

	Baseline (%)	After taVNS (%)	10 days after the end of treatment (%)
VAS	100	30	40
NePIQoL			
Pain and other symptoms	42	44	71
Relationships	45	55	75
Daily activities	19	35	35
How pain makes you feel	40	62	55
Personal/self-care	42	62	45
SF36			
Physical functioning	30	85	45
Role limitations due to physical health	0	75	25
Role limitations due to emotional problems	0	66	66
Energy/fatigue	5	55	55
Emotional well-being:	36	48	60
Social functioning	0	87	87
Pain	10	80	57
General health	25	35	40
Health change	50	100	100

VAS: Visual analog scale, SF36: Short form 36, NePIQoL: Neuropathic pain impact on quality-of-life questionnaire, taVNS: Transcutaneous auricular vagus nerve stimulation.

have shown that a large proportion of trigeminal ganglion neurons are glutamatergic, and that glutamate injection into the masseter muscle can evoke pain and allodynia.[14,15]

In our case, the patient exhibited pronounced reductions in masticatory muscle tenderness and unilateral facial pain following taVNS. VAS scores declined from 100% to 30% post-treatment and stabilized at 40% after 10 days. NePIQoL scores, particularly in the "Pain and Other Symptoms" domain, improved from 42 to 71, representing a 69% relative enhancement. Improvements were also observed in SF-36 parameters such as physical functioning, pain, and emotional well-being.

Anatomical studies have shown that the auricle is innervated by both the auricular branch of the vagus nerve and branches of the trigeminal nerve.[16] This overlapping innervation provides a plausible basis for indirect stimulation of trigeminal pathways during taVNS. Functional neuroimaging data further support this interaction: Badran et al.[13,17] demonstrated via concurrent taVNS and functional magnetic resonance imaging that stimulation of the tragus activates not only vagal-related nuclei but also broader somatosensory and limbic regions associated with pain processing.

In addition, a recent study by Hatik et al.[18] demonstrated the functional impact of taVNS during physical exertion, further supporting its potential in modulating neurophysiological responses. Furthermore, a comprehensive review by Yuan and Silberstein emphasized the growing evidence base for taVNS as a non-invasive treatment for headache disorders, suggesting translational value for conditions such as trigeminal neuralgia.[19]

Although this is a single case report, the observed improvements and literature support underline the potential of taVNS as an adjunct modality in the management of refractory trigeminal neuralgia. However, randomized controlled trials with larger sample sizes are needed to determine optimal stimulation parameters, treatment duration, and the specific contribution of trigeminal–vagal convergence to clinical outcomes.

Conclusion

In conclusion, taVNS should be regarded as a promising non-invasive neuromodulation technique for the management of pain in patients with trigeminal neuralgia. This case report demonstrated the clinical utility of taVNS in reducing pain and disability. The findings contribute to the growing body of evidence supporting taVNS and underscore the need for larger-scale, randomized studies to further elucidate its therapeutic mechanisms and optimize clinical protocols.

Disclosures

Ethics Committee Approval: This is a single case report, and therefore ethics committee approval was not required in accordance with institutional policies.

Informed Consent: Informed consent was obtained from the patient for the publication of the case report and the accompanying images.

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