



Influence of Vagus Nerve Stimulation for Better Physical and Mental Health

Shaik Khadeer Ahamad , Sanjana Reddy Thota, Deepthi Dara, Nehika Mukundu, Narender Boggula, Rama Rao Tadikonda

CMR College of Pharmacy, Kandlakoya, Medchal, Hyderabad, Telangana, India.

Corresponding Author's Email id: chukumunna95@gmail.com

ABSTRACT

Vagus nerve stimulation (VNS) is a promising therapeutic approach for improving both physical and mental health outcomes. The vagus nerve is a major nerve that connects the brain to various organs in the body, and stimulating it has been shown to have a range of benefits, including reducing inflammation, improving heart health, and regulating mood and anxiety. By its afferent and efferent channels, the vagus nerve, a significant part of the ANS, regulates metabolic balance and is crucial for the neuroendocrine-immune axis, which helps to maintain homeostasis. Any procedure that stimulates the vagus nerve, whether manually or electrically, is referred to as vagus nerve stimulation. In recent years, VNS has been studied as a treatment for a variety of conditions, including depression, anxiety, epilepsy, and chronic pain. Research suggests that VNS can improve symptoms in these conditions, with some studies indicating that it may even have neuroprotective effects. VNS can be achieved through a variety of methods, including implantable devices that deliver electrical stimulation to the vagus nerve and non-invasive techniques such as transcutaneous vagus nerve stimulation. While the precise mechanisms underlying the therapeutic effects of VNS are not yet fully understood, it is clear that this approach holds great promise for improving both physical and mental health outcomes in a variety of patient populations.

Key words: Vagus nerve stimulation, ANS, homeostasis, physical health, mental health.

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INTRODUCTION

The parasympathetic neural system, which regulates a wide range of vital biological processes including control of mood, immunological response, digestion, and heart rate, is mostly composed of the vagus nerve also referred to as pneumogastric nerve. It is the tenth cranial nerve, passing through the neck, thorax, and abdomen before beginning in the brainstem. It is also known as the "wanderer nerve" due to the length of its pathway through the human body.[1]

Any method that stimulates the vagus nerve can be generally referred to as "vagus nerve stimulation" (VNS).[2] Vagus nerve stimulation (VNS) is the process of electrically stimulating the vagus nerve with a tiny, surgically implanted device.

A surgical operation is required to implant a device powered by batteries that measures 1.5 inches wide beneath the skin of the chest to start a VNS. The device is connected to the left vagus nerve by a wire that is run under the skin from the chest to the neck. The surgically implanted device is set up by a clinician to send electrical impulses to the vagus nerve at various frequencies, currents, and durations. These signals pass through the vagus nerve to the brainstem, which then transmits them to particular regions of the brain, including those that control mood.[3]

The Influence of norepinephrine, serotonin, and other neurotransmitters involved in mood disorders can be influenced by this type of stimulation to aid in the treatment of a variety of physical and mental ailments.[4] BDNF, a protein linked to adaptability and stress tolerance, is also expressed more frequently in response to VNS.[5] Vagus nerve stimulation is involved in the majority of prevalent health issues and Functions like taste, swallowing, speech, heart rate, digestion, and excretion are influenced by the vagus nerve.[1] The therapy's capacity to foster calm and lower inflammation has a healing impact on a person's body.[6]

It also functions in the autonomic nervous system, which regulates unconscious functions like breathing and digestion.[7] It might also act as a bridge between the gut and the brain, contributing to the gut-brain axis, as described by scientists. Researchers have been examining the gut-brain axis in recent years to find for connections between illnesses like obesity and depression.[8] [9]

Ideal vagus high vagal tone index, is linked to strong social ties, happy feelings, and better physical health. Those who have a low vagal tone index are more likely to have heart attacks, strokes, loneliness, and depression.[10]

Epilepsy

VNS is frequently used in conjunction with anti-epileptic medications to treat neurological diseases including epilepsy. Vagus nerve stimulation stimulates the left vagus nerve repeatedly using implanted electrodes as a non-pharmacological palliative treatment for epilepsy.[11] Moreover, it might lessen abnormal electrical brain activity that causes seizures. This might lessen a person's seizure intensity, frequency, and duration. The process of the treatment, though, could take up to two years. Furthermore, VNS may enhance general wellbeing, post-seizure recovery, and mood, alertness, and cognition.

For those with refractory focal onset seizures who are 4 years of age or older, VNS is accepted as an additional therapy in the US. There are no age limits on the use of VNS as an additional therapy for individuals with generalised or focal onset seizures in the European Union.[12] It is advised that the patient be ineligible for epilepsy surgery and that VNS be pursued only after a sufficient trial of at least two carefully selected anti-seizure drugs.[13] VNS may be an option for patients with poor anti-seizure medication adherence or tolerance.[14]

For specific epilepsy syndromes and seizure types such Lennox-Gastaut syndrome, tuberous sclerosis complex associated epilepsy, refractory absence seizures, and atonic seizures, VNS may be beneficial.[15][16][17][18] Also, there are reports of patients with refractory and super-refractory status epilepticus benefiting from VNS.[19]

Inflammatory bowel disease

The main Inflammatory cytokine targeted by IBD treatment, TNF, has been demonstrated to be among the many inflammatory cytokines whose blood levels are decreased by vagal activity. Heart-rate variability, which can be easily detected on an ECG as variations in the RR interval between beats, is THE indicator of general vagal tone. Low levels of baseline vagal tone have been found in IBD patients using this method.[20]

Crohn's disease

In the case of moderate Crohn's disease, vagus nerve stimulation appears to be a novel and well-tolerated treatment. The patients' inflammatory state was reduced and their homeostatic vagal tone was restored due to VNS.[21]

Stroke

Enhancing functional independence and involvement in activities is one of the main objectives of stroke recovery. Neuromodulators that support plasticity, including acetylcholine and norepinephrine, are released when the vagus nerve is stimulated. The foundation for paired VNS therapy is the timely activation of neuromodulators in tandem with motor training to promote task-specific plasticity in the motor cortex and enhance function.[22]

Therefore, for individuals who have moderate to severe loss of arm and hand function as a result of an ischemic (blocked blood flow) stroke, VNS is approved as an adjunct to rehabilitation therapy.[23][24]

Rheumatoid arthritis

According to recent studies, cytokines, or immune system signals, are what control the vagal tone index. An Improvement in arthritis, a decrease in serum cytokine levels, and protection from joint degeneration are all brought on by stimulation of the vagus nerve or activation of the CAP.[25] Research is being conducted to learn more about the possibility for treating such inflammatory illnesses without the use of pharmaceutical medicines by activating the vagus nerve.[26]

Diabetes

Glycemic control and weight control may be possible with bilateral chronic vagal stimulation using stimulation parameters that are similar to those utilised in either epileptic or depressive patients.[27]

Depression

According to studies, comorbid depression raises the morbidity and mortality of individuals with pre-existing heart disease and is an independent risk factor for the development of cardiovascular disease.[28][29] Cardiovascular arrhythmias are also more likely to develop in those who are depressed.[30] Via its afferent and efferent channels, it regulates metabolic balance and is crucial for the neuro-endocrine-immune axis to maintain equilibrium.[31][32] Many patients with depression do not improve after receiving medication. Adult patients undergoing a major depressive episode who had not responded to four or more acceptable antidepressant medications were approved for vagus nerve stimulation as an additional long-term treatment for persistent or recurrent depression.[33]

Post traumatic stress disorder

A person's mental health is improved by VNS, which can also be used to treat chronic depression that is resistant to treatment and post-traumatic stress disorder (PTSD). The physical and cognitive symptoms of

illnesses linked to stress may be influenced by the vagus nerve. Stimulation may control a person's emotions, promoting calm, clarity, and compassion.[34]

Alzheimer's disease

Vagal nerve stimulation, which can promote neural plasticity, change the accumulation of A pathology, improve metabolic support of neuronal function via astrocytes, and offer anti-inflammatory signalling, has the potential to target numerous AD processes and affect disease development.[35]

Migraine

Through its anti-nociceptive effects, VNS may lower the frequency and intensity of migraine headaches, and chronic VNS therapy may be advantageous for the preventative treatment of migraine.[36]

Obsessive compulsive disorder

The effectiveness of VNS in treating OCD in patients has been inconsistent, necessitating further study.[37]

Parkinson's disease

Through the solitary nucleus, vagus nerve stimulation (VNS) affects brain rhythms in the locus coeruleus (LC). Parkinson's disease (PD) related LC degeneration is an early trigger of the spreading neurodegenerative process, indicating that increasing LC output using VNS has the potential to alter the course of the disease.

The largest reduction of behavioural and clinical indicators was shown in this PD model with higher stimulation frequencies, suggesting therapeutic promise for these VNS paradigms.[38]

Autism

Vagal stimulation can alter the cortical and subcortical processes, especially those of the thalamus and amygdala, which may in turn regulate the abnormal brain activity associated with ASD.[39]

CONCLUSION

Stimulation of the vagal nerve has shown to be a beneficial non-pharmacological treatment options for some most common conditions. However, it is reported to be more widely used only for epilepsy and depression and for its implementation for other disorders requires more research and evidence from human subjects.

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