# Perioperative Management and Anaesthetic Considerations in Vagal Nerve Stimulators' Implantation in Refractory Epilepsy: First Case Series from Pakistan

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## ABSTRACT

This case series reports the first-ever successful implantation of vagal nerve stimulators (VNS) for refractory epilepsy in this region. It details the anaesthetic management of two patients who underwent VNS implantation, both of whom achieved positive outcomes with stable postoperative recovery. Comprehensive preoperative evaluations were conducted by the anaesthesia and neurosurgery teams. American Society of Anesthesiologists (ASA) II standard monitoring was employed without invasive lines, and intraoperative analgesia was managed with systemic agents. Anaesthesia played a key role in ensuring cardiovascular stability and a proactive approach to managing potential bradycardia. Both patients remained pain-free and haemodynamically stable throughout the procedure and during the initiation of vagal nerve stimulation. Postoperatively, patients experienced effective pain control, reduced nausea and vomiting, and shorter hospital stays. This case series highlights a significant advancement in our region's anaesthetic and surgical capabilities, contributing to the learning and expertise required for future VNS procedures.

**Key Words:** *Anaesthesia, Refractory epilepsy, Vagal nerve stimulator, Bradycardia.*

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## INTRODUCTION

The incidence of refractory epilepsy remains significant despite the introduction of numerous new antiepileptic drugs (AEDs) over the past decade.[1] Studies show that newly diagnosed epilepsy may eventually become resistant to treatment in around 20–40% of patients.[2-4] Patient's response to AED therapy can be predicted by factors such as epilepsy type, underlying syndrome, cause, and the history of seizure frequency, severity, and patterns.[5] Vagal nerve stimulation (VNS) serves as a valuable complementary treatment for cases of medically refractory epilepsy and severe depression.[4,6-8] VNS was approved by the US Food and Drug Administration (FDA) in 1997 and has been used as an adjunctive treatment for medically intractable epilepsy.[9] It leads to a 50% reduction in seizure frequency with optimal benefits seen after 6-12 months.[7] VNS cannot completely cure epilepsy; however, it can provide long-term seizure control and enhance quality of life by decreasing sudden unexpected death as well.[7] Furthermore, it demonstrates promise in addressing conditions such as cluster headaches, migraine, Alzheimer's disease, fibromyalgia, obesity, and various psychological disorders such as schizophrenia or autism.[10]

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With the growing list of applications, an increasing number of patients qualify for the surgical implantation of a commercial VNS device.[11] While it has a well-established safety profile, VNS may sometimes cause hoarseness (3-66%), cough (45%), dyspnoea (25%), vocal cord paralysis (1%), dysphagia, or paresthaesia.[5] Although surgical risks are minimal, careful patient selection is essential.[9,10] VNS is typically performed under general anaesthesia, and the left vagus nerve is preferred to minimise cardiac effects.[5] Certain anaesthetic adjustments may be required, such as avoidance of ketamine or other opioids because of their pro-convulsant properties.[5] The primary objective of this case series is to share our experience of managing the surgical insertion of a VNS device under general anaesthesia, possible complications during the perioperative period of initial VNS implantation, and the associated anaesthetic management considerations.

### CASE 1:

A 36-year male, with a known case of refractory epilepsy since childhood, hypertensive for three years, and weighing 96 kg, presented with a history of childhood epilepsy that was uncontrolled on medication. The patient used to have 4-6 events of generalised tonic-clonic (GTC) seizures daily despite being on medication. The patient was taking lamotrigine and levetiracetam for seizure control and Amlodipine for hypertension, which was controlled. General and systemic examinations were normal. Baseline laboratory parameters were unremarkable, and airway assessment was normal.

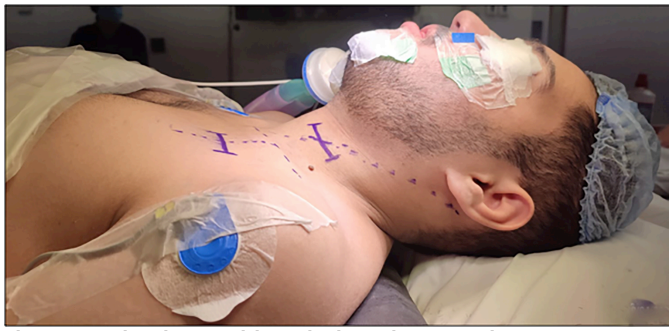

**Figure 1: Patient image with marked vagal nerve pathway.**

### CASE 2:

A 22-year male, with a known case of epilepsy since childhood, weighing 69 kg, presented with an uncontrolled epilepsy since childhood despite being on anti-epileptic medications. The patient used to have almost 15 episodes of GTC seizures of a few seconds. The patient was taking clonazepam, valproic acid, levetiracetam, oxcarbazepine, lacosamide, and dexamethasone for seizure control. General and systemic examinations, along with airway assessment, were normal. Baseline laboratory parameters were unremarkable. The MRI brain showed focal cortical dysplasia in the left frontal lobe, which was a suspected cause of seizure trigger.

VNS device placement surgery was planned for both patients as a treatment modality for refractory epilepsy, for which patients had pre-operative anaesthesia and neurosurgical assessment. The patients were provided thorough explanation of the procedure and the operating room setup. Additionally, educational brochures were provided to help them understand the upcoming steps. Intra-operatively, ASA-II standard monitoring was applied, and two large-bore IV cannulas were inserted. Emergency medicines, including atropine, phenylephrine, and epinephrine, were prepared to counter any event of bradycardia. The procedure of induction was started with propofol at 2 mg/kg along with nalbuphine 0.1 mg/kg for analgesia and cis-atracurium 0.2 mg/kg for muscle relaxation. Both patients were then intubated with a size 8.0 mm PVC endotracheal tube, and ventilation mode was set on volume control ventilation as per the desired tidal volume of 7 ml/kg, and sevoflurane was started as a maintenance agent. A loading dose of levetiracetam 1 g was given to both patients for epilepsy prophylaxis, along with ondansetron 0.1 mg/kg and dexamethasone 0.1 mg/kg for postoperative nausea and vomiting prophylaxis. The patient who was preoperatively on dexamethasone for seizure control was given a stress dose of hydrocortisone 150 mg along with co-induction with midazolam 2 mg as well for seizure prophylaxis.

The patients were positioned with neck extension and a rightward tilt to expose the left side of the neck for the incision (Figure 1). The procedure started, and the patients were kept vitally and haemodynamically stable along with adequate pain control. Close observations were maintained while working on vagal nerve manipulation and stimulation after device installation. Intraoperatively, there was no event of bradycardia or seizure reported, and the surgery went smoothly. Estimated blood loss in both surgeries was 100 ml and 120 ml, respectively, while surgery lasted for 180 minutes and 120 minutes, respectively. The post-anaesthesia care unit (PACU) stay was uneventful, and both patients were discharged to their wards after their PACU stay. The postoperative analgesia was prescribed with intermittent doses of paracetamol and tramadol, and both patients were discharged on the second postoperative day.

## DISCUSSION

VNS has demonstrated efficacy in reducing seizures among patients with epilepsy. A multicentre, prospective, randomised controlled trial demonstrated a significant reduction of 31% in the frequency of seizures in the high-stimulation group, compared to just 11% in the low-stimulation group.[12] VNS has been a common practice in the West and developed countries as a treatment modality for refractory epilepsy for over a decade, but unfortunately, in Pakistan, no such practice is being done due to a lack of resources and clinical expertise for this treatment option. These cases were unique as these were the first cases being conducted in Karachi, Pakistan. VNS includes implanting a device that emits periodic electrical impulses to the left vagus nerve in the neck. This device has three main parts: A pulse generator (placed under the skin), a lead wire connecting it to the nerve, and an electrode stimulating the nerve. While the exact mechanism of VNS's effect on seizures is unknown, it is thought to work by triggering nerve signals that travel to the brain, influencing areas such as the limbic system, brainstem arousal systems, and neurotransmitter systems, ultimately reducing neuronal excitability. Notably, VNS does not monitor brain or muscle activity and cannot react to seizures as they happen.[13] The effects of VNS may result from the modulation of electrical signals through either stimulation or suppression, achieved by altering electrical or chemical properties. The left vagus nerve is preferred for the placement of a VNS device due to the very high association of the right vagus nerve to cardiac efferent fibres,[14] whose stimulation may result in more frequent adverse cardiac complications.

For perioperative management, the AEDs are continued until the morning of surgery.[15] Placement of the device is conducted under general anaesthesia with endotracheal intubation, ensuring meticulous ventilation management to maintain normocarbia, as hyperventilation could trigger seizures. There is an increased risk of bleeding from the carotid artery or the jugular vein; therefore, intravenous access should be adequate for blood transfusion and volume resuscitation. Effective and successful anaesthetic management during VNS implantation necessitates understanding the convulsant/anticonvulsant properties of both intravenous and inhaled anaesthetics in different scenarios. Some opioids, such as tramadol and meperidine (pethidine), which lower the seizure threshold and produce electroencephalogram (EEG) epileptiform activity, should be considered while planning analgesia in this surgery. Along with the standard monitors recommended by the ASA, the severity of

cardiovascular or respiratory conditions directs the invasive monitoring. While EEG monitoring is not typically recommended, monitoring of awareness intraoperatively should follow the guidelines established by the ASA. Major postoperative complications consist of seizures and haematoma formation in the peritracheal region due to damage to the carotid artery or the jugular vein, while vocal cord paralysis or hoarseness can also occur due to vagal nerve injury. In cases where patients exhibit delayed awakening or altered mental state, postoperative seizures should be considered a likely cause of the complication.

Although VNS is a well-established procedure globally, this case series represents the first of its kind performed and documented in this region. Given the limited experience of our anaesthesia teams with this technique, there is a need for enhanced training and familiarity with its specific anaesthetic considerations. By sharing these cases, we aim to contribute to the knowledge base of anaesthetic physicians in this region, supporting improved patient care and procedural confidence in future VNS interventions.

**PATIENTS' CONSENT:**

Informed consent was obtained from the patients that they understand the process and that the information provided about them and their treatment can be used for research purposes, provided their name and other details are kept anonymous.

**COMPETING INTEREST:**

The authors declared no conflict of interest.

**AUTHORS' CONTRIBUTION:**

FT: Conception, design, acquisition of the data, analysis, interpretation and drafting.
STBZ: Design of the work, acquisition, analysis, interpretation, drafting, reviewing, and editing.
HU: Conception, design, supervision.
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## REFERENCES


1. Lukawski K, Czuczwar SJ. Understanding mechanisms of drug resistance in epilepsy and strategies for overcoming it. *Expert Opin Drug Metab Toxicol* 2021; **17(9)**:1075-90. doi: 10.1080/17425255.2021.1959912.
2. Wilcox KS, Dixon-Salazar T, Sills GJ, Ben-Menachem E, White HS, Porter RJ, *et al*. Issues related to development of new antiseizure treatments. *Epilepsia* 2013; **54 Suppl 4(0 4)**: 24-34. doi: 10.1111/epi.12296.
3. Ventola CL. Epilepsy management: Newer agents, unmet needs, and future treatment strategies. *P T* 2014; **39(11)**: 776-92.
4. Dolezalova I, Koritakova E, Souckova L, Chrastina J, Chladek J, Stepanova R, *et al*. Prediction of vagal nerve stimulation efficacy in drug-resistant epilepsy (PRECISE): Prospective study for pre-implantation prediction/study design. *Front Neurol* 2022; **13**:839163. doi: 10.3389/fneur.2022.839163.
5. Hatton KW, McLarney JT, Pittman T, Fahy BG. Vagal nerve stimulation: Overview and implications for anesthesiologists. *Anesth Analg* 2006; **103(5)**:1241-9. doi: 10.1213/01.ane.0000244532.71743.c6.
6. Ohemeng KK, Parham K. Vagal nerve stimulation: Indications, implantation, and outcomes. *Otolaryngol Clin North Am* 2020; **53(1)**:127-43. doi: 10.1016/j.otc.2019.09.008.
7. Terra VC, Amorim R, Silvado C, Oliveira AJ, Jorge CL, Faveret E, *et al*. Vagus nerve stimulator in patients with epilepsy: Indications and recommendations for use. *Arq Neuropsiquiatr* 2013; **71(11)**:902-6. doi: 10.1590/0004-282X 20130116.
8. Kavakbasi E, Baune BT. [Vagus Nerve Stimulation (VNS) in Depression]. *Fortschr Neurol Psychiatr* 2023. doi: 10.1055/a-2165-7860.
9. Horowitz G, Amit M, Fried I, Neufeld MY, Sharf L, Kramer U, *et al*. Vagal nerve stimulation for refractory epilepsy: The surgical procedure and complications in 100 implantations by a single medical center. *Eur Arch Otorhinolaryngol* 2013; **270(1)**:355. doi: 10.1007/s00405-012-2118-0.
10. Toffa DH, Touma L, El Meskine T, Bouthillier A, Nguyen DK. Learnings from 30 years of reported efficacy and safety of vagus nerve stimulation (VNS) for epilepsy treatment: A critical review. *Seizure* 2020; **83**:104-23. doi: 10.1016/j.seizure.2020.09.027.
11. Guberman A. Vagus nerve stimulation in the treatment of epilepsy. *CMAJ* 2004; **171(10)**:1165-6. doi: 10.1503/cmaj.1041039.
12. Cohen-Gadol AA, Britton JW, Wetjen NM, Marsh WR, Meyer FB, Raffel C. Neurostimulation therapy for epilepsy: Current modalities and future directions. *Mayo Clin Proc* 2003; **78(2)**:238-48. doi: 10.4065/78.2.238.
13. Henry TR. Therapeutic mechanisms of vagus nerve stimulation. *Neurology* 2002; **59(6 Suppl 4)**:S3-14. doi: 10.1212/wnl.59.6_suppl_4.s3.
14. Saper CB, Kibbe MR, Hurley KM, Spencer S, Holmes HR, Leahy KM, *et al*. Brain natriuretic peptide-like immuno reactive innervation of the cardiovascular and cerebrovascular systems in the rat. *Circ Res* 1990; **67(6)**:1345-54. doi: 10.1161/01.res.67.6.1345.
15. Roizen MF, Fleisher LA. Anaesthetic implications of concurrent diseases. In: Miller RD, Ed. Miller's Anaesthesia. 9th ed. Philadelphia, PA: Elsevier, Churchill Livingstone, 2005: p. 1017-149.