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# High-Flow Nasal Cannula in a Parkinson's Disease Patient Undergoing Deep Brain Stimulation in the Awake State

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## Abstract

The administration of deep brain stimulation (DBS) in patients with Parkinson's disease is commonly carried out with the patient in an awake state with conscious sedation. However, maintaining the airway and preventing desaturation can be challenging during the procedure. High-flow nasal cannula (HFNC) has been deemed to be a safe option for providing respiratory support in such patients, affording multiple benefits. We report the case of a 48-year-old male patient with Parkinson's disease who underwent DBS, during which HFNC was employed for respiratory support. The patient tolerated the HFNC well, and the procedure was conducted without any complications related to respiratory function.

**Keywords**

- Parkinson's
- deep brain stimulation
- high-flow nasal cannula
- conscious sedation
- awake state

## Introduction

During Deep Brain Stimulation (DBS) in Parkinson's disease patients, it is important to consider airway compromise during conscious sedation. Around one-third of these patients have an obstructive lung disease pattern, which is associated with chronic obstructive pulmonary disease and obstructive sleep apnea. They also experience abnormal control and function of the upper airway and pharyngeal muscle dysfunction, which can lead to aspiration. In these patients, intraoperative respiratory complications occur in 1.6–2.2% and seizures in 0.5–4.5% during DBS.[1] High Flow Nasal Cannula (HFNC) is a safe option for providing respiratory support in such patients, offering multiple benefits. We present the case of a 48-year-old male patient with Parkinson's disease who underwent deep brain stimulation, during which HFNC was employed for respiratory support.

## Case Report

A 48-year-old man, with a known case of Parkinson's disease and on medication, presented to the outpatient department with chief complaints of stiffness, abnormal movements in the body, and change in speech for 11 years. He had no family history of Parkinson's disease. He worked as a lecturer. He was on stable antiparkinsonian medication therapy consisting of rasagiline, syndopa, and amantadine. Despite taking these medications, he suffered severe resting tremor in all limbs. For the last 4 years, his symptoms became moderately disabling affecting his daily activities and resulting in a decline in his work performance. He had no other significant medical or surgical history. Preoperative evaluation of the patient was done by a multidisciplinary approach involving a team consisting of neuroanesthetists, neurologists, neurosurgeons, and neuropsychologists. After consultation, he was considered a good candidate for the procedure.

The patient was posted for deep brain stimulation (DBS) and bilateral placement of subthalamic nucleus DBS leads under conscious sedation. Preoperative counseling for conscious sedation was done. The patient and his family were given detailed verbal and written information about the procedure, risks and potential benefits, and the limitations of the surgery. The patient was admitted the evening before surgery. A standard preoperative fasting regimen was

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implemented. Anti-parkinsonism medications were withheld on the morning of surgery to render the patient in an off-drug state for intraoperative neurological testing. On the day of the procedure, informed consent from the patient was taken. The patient was taken inside the operation room. All American Society of Anesthesiologists (ASA) standard monitors including electrocardiogram, pulse oximetry, and noninvasive blood pressure were attached. An intravenous canula was secured. No premedication was given. Preoperative neurological status was documented. Dexmedetomidine infusion was started, and a loading dose was given followed by a maintenance dose. A bilateral scalp block was given using local anesthetics. Leksell's stereotactic frame was applied to the patient. With a stereotactic frame in place, the patient was taken to a magnetic resonance imaging (MRI) suite and MRI was performed to identify target nuclei and allow surgical planning. After surgical planning was completed, the patient was then shifted to the operation room for electrode insertion. In the operation theater, the patient, with the headframe attached, was carefully positioned in the semi-sitting position with special emphasis on patient comfort. Oxygen supplementation with high-flow nasal cannula (HFNC) was given (►**Fig. 1**). The flow was set at 40 L/min, with $FiO_2$ at 50%. Sedation was continued during the creation of the burr hole, first on the right side and then on the left side. After burr hole creation, the DBS electrode was passed down to the target area. Twenty minutes before microelectrode recording (MER), dexmedetomidine infusion was stopped to avoid possible interference with MER. The final placement of both DBS electrodes was done after a neurological examination with macrostimulation of the electrodes.

Intraoperative macrostimulation testing showed a significant reduction of motor symptoms bilaterally as assessed by a movement disorder neurologist. Once the electrodes were inserted, burr holes were closed off. It was followed by radiological confirmation. Implantation of the pulse generator and internalization of electrodes were performed on the same day under general anesthesia. After preoxygenation and premedication with injection midazolam 0.02 mg/kg and fentanyl 2 µg/kg, the patient was induced with injection propofol 2 mg/kg and injection vecuronium 0.1 mg/kg, and endotracheal tube with an 8.0-mm inner diameter (ID) was secured. Anesthesia was maintained on an oxygen-air and sevoflurane mixture. The patient was extubated and shifted to the intensive care unit (ICU). The total duration of the surgery was 8 hours. The patient received the usual anti-parkinsonism medication as soon as possible to avoid motor fluctuation that could cause profound deterioration in neurological function and respiratory muscle impairment. No complications were observed at the time of surgery. The patient remained conscious, cooperative, and alert during all stages of the procedure.

## Discussion

HFNC was chosen for oxygenation for several reasons. It delivers heated (36°C) and humidified air at flows up to 90 L/min through a nasal cannula, delivers positive end-expiratory pressure (PEEP), and decreases anatomic dead space.[2] Heated humidified air flow decreases mucociliary dysfunction, while the higher flow leads to maintenance of continuous positive airway pressure (CPAP), thereby stenting the airway and preventing airway collapse.[3] Oxygen flow settings are easily titrated by adjusting a manual dial from 0.2 to 1.0.

### Physiology of Thrive

The HFNC by transnasal humidified rapid-insufflation ventilatory exchange (THRIVE) is an air-oxygen blender.[4] The THRIVE method facilitates ventilation through a noninvasive nasal route. It involves the administration of high-flow nasal oxygen at a rate of 40 to 90L/min, creating a turbulent "primary supraglottic vortex." This vortex continuously

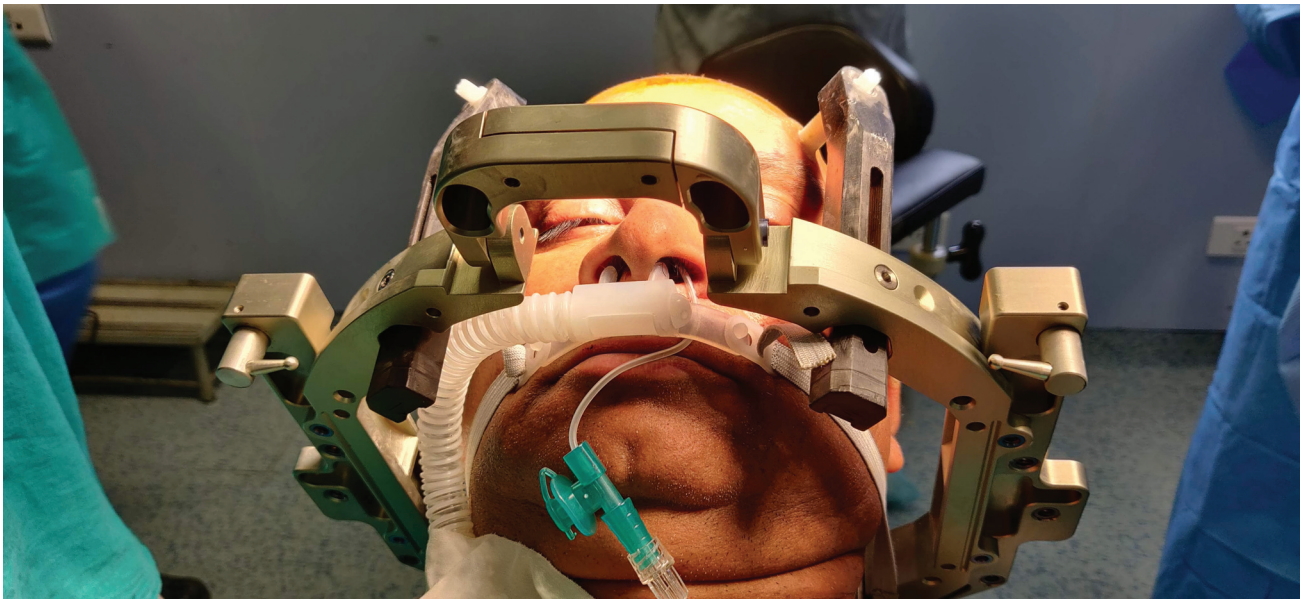

**Fig. 1** Showing high-flow nasal cannula (HFNC) applied to the patient undergoing deep brain stimulation in the awake state.

 

delivers oxygen to the pharynx and prevents the inhalation of room air. By effectively bypassing the upper airways, which typically contribute to around 50% of the respiratory system's airflow resistance, THRIVE reduces the work of breathing by approximately 50%.[5] The high flows, achieved through proper warming and humidification, also result in a positive airway pressure even when the mouth is open. Thus, the air being expired from the lung will be opposed by the fresh gas flow from the HFNC, which produces a PEEP-like effect, changing the lung volume and influencing ventilation.[6] This pressure helps minimize upper airway collapsibility and distal airway atelectasis.[7]

The device makes very little noise and despite the high flow rate, it interferes little with voice generation by the patient during the awake phase. With increasing levels of HFNC, the swallowing function is enhanced by reducing latency of the swallow reflex.[8]

Using HFNC in these patients can increase their respiratory reserve through improved oxygenation and ventilation and attenuate hypercarbia from hypoventilation.[9] A significant reserve for apnea allows more time for emergent intubation or supraglottic airway placement if airway protection is needed.[10] Although dexmedetomidine causes less respiratory suppression, it acts synergistically with other sedative agents and its oversedation can lead to upper airway collapse and obstruction.[9]

Intraoperative macrostimulation could not have been performed if the patient was under general anesthesia, leading to a suboptimal outcome. The use of HFNC allowed the prevention of invasive airway management, which would have rendered testing nonviable.[11] The patient remained comfortable and did not complain of any dryness and sore throat perioperatively. Higher flows delivered through HFNC could also be beneficial in cases of an emergency, for example, an intraprocedural seizure, as it reduces the risk of desaturation and improves the apneic oxygenation time allowing prevention of escalation of respiratory support and adds more time for airway management in suboptimal conditions.[10] In a study conducted by Paquin-Lanthier et al, which aimed to assess the risk factors and characteristics of intraoperative seizures during awake craniotomy, an incidence rate of 5% for intraoperative seizures was identified. The study also found an independent association between intraoperative dexmedetomidine use and the occurrence of intraoperative seizures.[12] The nasal interface of the HFNC system consists of soft silicone and has a wider bore than traditional nasal prongs. HFNC is generally well tolerated compared to other means of oxygen supplementation, such as a low-flow nasal cannula or a facemask. Patients can tolerate HFNC with a flow rate of up to 100 L/min without experiencing discomfort and claustrophobia.[13]

By using standard oxygenation methods like face masks or nasal prongs, $FiO_2$ pharyngeal values may be unstable. HFNC limits air entrainment, enhancing pharyngeal $FiO_2$ values (►**Fig. 2**). The evolving use of high-flow nasal oxygenation during awake craniotomies serves as a bridge to tide over the need for definitive airway access, especially in patients with obstructive sleep apnea.[14]

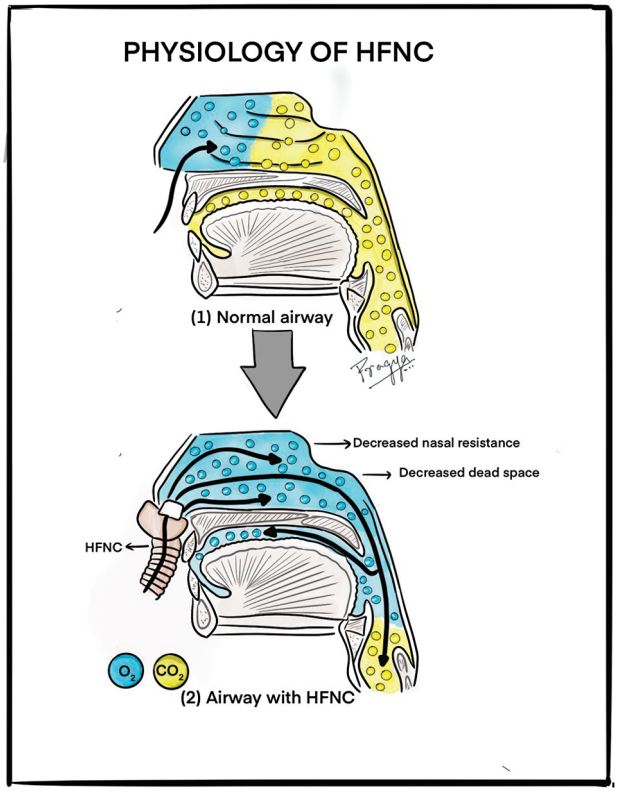


**Fig. 2** Showing the mechanism of action of high-flow nasal cannula (HFNC) by creating a primary supraglottic vortex in the nasopharyngeal cavity.

The spontaneous breathing can be maintained with mild to moderate sedation (bispectral index [BIS] value 60–80) through nasopharyngeal or oropharyngeal airways. However, upper airway obstruction cannot be completely relieved by the nasopharyngeal or oropharyngeal airway, and the concentration of inhaled oxygen cannot be adjusted. The nasopharyngeal airway can cause injury to the nasopharynx, and obstruction of the airway by secretions or blood clots. Some patients may have difficulty tolerating the nasopharyngeal or oropharyngeal airways or feel uncomfortable due to the dry airway.[10]

To maintain the patient's sedation depth during the surgery, doses of anesthetics were adjusted according to the BIS values. The initial flow rate should be set at 40 L/min, which could be increased during the operation if the patient has upper airway obstruction or other complications. When the upper airway obstruction cannot be relieved by increasing the inspired flow or position adjustment, an airway management device (such as nasopharynx or oropharyngeal airway) must be immediately applied.

## Conclusion

HFNC effectively provides oxygenation to Parkinson's disease patients during awake deep brain stimulation. It serves as a bridge between conventional oxygen therapy and mechanical ventilation. Further research is needed to compare its

effectiveness with other oxygen therapy modalities for these patients.

**Conflict of Interest**
None declared.

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