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Case Report
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Postoperative use of high flow nasal insufflation for obstructive sleep apnea
-a case series-

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Background: Continuous positive airway pressure (CPAP) therapy is the gold standard treatment for obstructive sleep apnea (OSA), although, associated with poor patient compliance. Conversely, high flow, humidified, temperature-regulated nasal insufflation of oxygen or air is well tolerated.
Case: We describe our experience of three patients with known or suspected moderate to severe OSA who were poorly compliant to CPAP therapy and received high flow nasal insufflation (HFNI) postoperatively. None had significant episodes of desaturation (SpO_2 < 95%) and all patients uniformly reported superior comfort levels than with the CPAP therapy. HFNI generates small amounts of positive end-expiratory pharyngeal pressure, increases inspiratory airflow and decreases dead space ventilation. Due to the open system, less difficulty with the patient-mask interface and improved patient comfort is experienced. These factors help prevent hypopnea and lead to enhanced sleep continuity.
Conclusions: HFNI may be a promising alternative to CPAP therapy in the perioperative setting.

Keywords: Continuous positive airway pressure; High flow nasal oxygen; Hypopnea; Obstructive sleep apnea; Optiflow; Respiratory distress index; STOP-Bang Score.

Obstructive sleep apnea (OSA) is characterized by repeated collapse of the upper airway, leading to episodes of apnea and hypopnea during sleep. In the perioperative setting, the body's normal response to anesthetic agents may be exaggerated in OSA patients, disrupting the arousal mechanisms and ventilatory responsiveness, potentiating upper airway obstruction [1]. Published literature, using the STOP-Bang Score, estimate that up to 40% of patients presenting for elective surgery may be at high risk of OSA [2]. Presently, continuous positive airway pressure (CPAP) therapy is the mainstay of treatment for OSA. Its use in the perioperative period may reduce adverse postoperative outcomes associated with OSA [3]. The reported compliance rates to CPAP therapy are dismal, ranging between 20% and 40%, as it is perceived to be uncomfortable and obtrusive [4]. Conversely, high flow nasal insufflation (HFNI) therapy, with its ability to provide low levels of continuous positive airway pressure via the insufflation of high flow, humidified, temperature-regulated, oxygen-enriched air, is generally well tolerated in both pediatric and adult patients. We describe here, the use of HFNI in the management of three OSA patients during their first postoperative night.

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Case Reports

Informed consent was obtained for the purposes of publishing our experience with this therapeutic modality.

Case 1

A 34-year-old male with severe OSA (Apnea-Hypopnea Index of 104 /h), body mass index (BMI) of 45 kg/m^2 and a STOP-Bang Score of 5 (snoring, day time sleepiness/fatigue, BMI > 35, collar size > 17 inches, male sex) underwent a bilateral tonsillectomy. He had been on CPAP therapy previously but was non-compliant. The procedure was conducted under general anesthesia and endotracheal intubation. He had a total of 170 μg of fentanyl (1.8 μg/kg) perioperatively. He was managed postoperatively with 40 L/min HFNI on room air using the AIRVO^{TM}2 Optiflow^{TM} (Fisher & Paykel Healthcare Limited, New Zealand) in the high dependency unit (HDU). Overnight, there were no significant episodes of desaturation (a DI4 = average number of desaturations as measured by pulse oximetry (SpO_2) of ≥ 4% below baseline lasting 10 seconds or more, or CT90 = cumulative percentage of time at SpO_2 < 90%) [5] recorded, and the patient reported improved sleep quality with decreased arousals. He cited the increased ability to lie on his side and relative comfort of the device, compared to the CPAP face mask, as factors that increased his satisfaction with HFNI. He reported a visual analogue scale (VAS) comfort score of 100 mm for the HFNI therapy, compared to 20 mm for the CPAP therapy.

Case 2

A 68-year-old female with a BMI of 43 kg/m^2 and STOP-Bang Score of 5 (snoring, hypertension, BMI > 35, age > 50, collar size > 17 inches), ischemic heart disease, type 1 diabetes mellitus, congestive cardiac failure and hyperlipidemia presented for an elective bilateral tonsillectomy. She had been commenced on home CPAP therapy two days prior to surgery as part of the institution's perioperative optimisation protocol. This was poorly tolerated and she was non-compliant as she found it too uncomfortable. The procedure was conducted under general anesthesia and endotracheal intubation. She had a total of 250 μg of fentanyl (3 μg/kg) perioperatively. She was managed postoperatively on 30 L/min HFNI at a fraction of inspired oxygen (FiO_2) of 0.3 in the HDU. There were no documented DI4 or CT90 episodes, and no additional intervention was required for the OSA. She reported a VAS comfort score of 100 mm for the HFNI therapy, compared to 20 mm for the CPAP therapy.

Case 3

A 53-year-old female with a BMI of 44.1 kg/m^2 and a STOP-Bang Score of 5 (snoring, hypertension, BMI > 35, age > 50, collar size > 17 inches) was presented for an emergency bilateral breast and back debridement secondary to wound breakdown, following an elective mastectomy and reconstructive flap surgery 10 days prior. The procedure was done under general anesthesia and endotracheal intubation. She had a total of 6 mg of oxycodone (0.05 mg/kg) and 100 μg of fentanyl (0.8 μg/kg) perioperatively. She had been commenced on nocturnal home CPAP therapy two days prior to her first elective surgery. She was non-compliant with CPAP therapy as she found it noisy and felt that it induced a choking sensation. After her first elective procedure, she remained intubated on the first postoperative night.

The emergency procedure concluded uneventfully, and she was managed postoperatively with 40 L/min HFNI on room air in the HDU. There was no documented DI4 or CT90, and no additional intervention was required related to the OSA. She was compliant with the HFNI throughout the first postoperative night, and reported a VAS comfort score of 100 mm for the HFNI therapy, compared to 0 mm for the CPAP therapy.

Discussion

In our small case series of patients with OSA who were non-compliant to CPAP therapy, and started on HFNI postoperatively, there were no documented DI4 or CT90 episodes [5]. The above findings are summarized in Table 1, which elucidates the SpO_2 and respiratory rate recordings of the preoperative and first postoperative night of the three cases. In addition, none of them required further intervention with respect to OSA during the first postoperative night. They uniformly reported satisfaction with the comfort and perceived efficacy of HFNI therapy.

Our institutional protocol's initial set up of the HFNI aims to achieve the patients' resting SpO_2, with the optimal flow rate titrated against their comfort levels. This would first be done on room air, before small increments in the FiO_2 if the desired SpO_2 was not achieved.

Given that the worldwide prevalence of OSA is between 9% and 24%, a significant number of patients presenting for elective surgery are at high risk of OSA and its repercussions, there is a need for institutional protocols to identify and treat these individuals perioperatively [6]. Although CPAP therapy remains the treatment of choice, there is no clear evidence with regards to the optimal duration of CPAP therapy prior to surgery. Our institution's perioperative optimization protocol commences home nocturnal CPAP therapy two days prior to surgery to facilitate the sizing and familiarization with the face mask and machine.

Table 1. SpO_2 and Respiratory Rates Recordings of the Preoperative and First Postoperative Night

	Case 1 (40 L/min, room air)		Case 2 (30 L/min, FiO_2 = 0.3)		Case 3 (40 L/min, room air)	
	SpO_2 (%)	RR	SpO_2 (%)	RR	SpO_2 (%)	RR
T0	97	15	96	16	96	15
T20	95	20	96	20	99	18
T21	94	20	97	20	96	18
T22	97	21	96	20	96	17
T23	96	19	96	19	96	17
T24	98	21	95	17	95	18
T1	95	18	96	18	95	18
T2	95	19	96	17	95	18
T3	95	15	96	20	95	16
T4	97	14	95	20	96	17
T5	95	19	95	17	95	19
T6	95	25	95	17	96	20
T7	97	16	95	20	96	17
T8	98	15	96	18	97	19

T0: Pre-operatively (room air), T20–24: 8–12 p.m., T1–8: 1–8 a.m., RR: respiratory rate/min.

It is known that long term compliance to conventional CPAP therapy is poor, due to a variety of factors, including claustrophobia induced by a tight-fitting mask, pressure effects of the mask and straps, airway irritation, xerostomia and difficulty tolerating the positive pressure in a closed circuit [7]. The compliance rate in our institution is up to 40%, which is similar to reported numbers [4], and this is where we postulate that HFNI may play an important role as an alternative treatment option in patients who are unable to tolerate conventional CPAP therapy.

HFNI has gained favour in the management of respiratory failure in pediatrics and adults. It provides temperature-regulated and humidified oxygen at high flow rates (up to 70 L/min) with a predictable FiO_2 (up to 1).

Humidified gases preserve the mucociliary function of the airways, allowing the removal of secretions, thereby minimising the degree of atelectasis [4]. A study by Woodson and Robbins [8] comparing humidified and dry air inhaled via the oral route found that the latter caused a decrease in lung compliance. The provision of warm, humidified air serves a dual purpose. It improves comfort by preventing nasal and oral mucosal dryness and may also improve the delivery of oxygen, minimising ventilation/perfusion mismatch.

Similar to conventional CPAP therapy, HFNI causes upper airway distension, with higher pressures seen with mouth closure and increasing flow rates [9]. These pressures range from between 2.9 cmH_2O on 30 L/min to 11.4 cmH_2O with very high flow rates of 100 L/min [10]. This is somewhat lower than the mean CPAP pressures of 5.5 to 12.5 cmH_2O that is required by patients with OSA, a value which increases proportionally with the severity of the OSA [11]. Despite generating lower pressures, HFNI still managed to alleviate the upper airway closure in the patients in our case series, who were likely to have significant sleep apnea based on their STOP-Bang Scores. McGinley et al. [12] were also able to demonstrate a reduction in the apnea-hypopnea and arousal indices in patients with mild to severe OSA despite using HFNI at 20 L/min.

HFNI also increases the end-expiratory lung volume which may contribute to alveolar recruitment. This effect seems more pronounced in OSA patients who predominantly suffer from hypopnea, rather than apneic patterns of breathing [13].

In addition, HFNI facilitates more stable and synchronised breathing patterns by providing larger oxygen stores with increased lung volume and upper airway patency [12]. The high flow rate washes out CO_2, eliminates dead space and provides the upper airway passages with an oxygen reservoir. These changes are seen in obese patients as well as patients in the prone position [14].

Last but not least, HFNI lowers airway resistance and reduces the work of breathing. During normal inspiration, the distensibility of the nasopharynx increases airway resistance as it draws in the boundaries of the nasopharyngeal wall. It is likely that the flow rates of the HFNI matches or exceeds the patients' peak inspiratory flow rates, leading to a reduction in this resistance [15].

The apparent comfort and unobtrusive nature of HFNI may prove to be pivotal in improving our patients' acceptance of, and compliance to, this therapy. Given its multiple benefits, and the need for an alternative treatment modality to conventional CPAP for non-compliant OSA patients, HFNI presents an attractive option. We propose that large randomised studies assessing the efficacy and safety of HFNI in OSA patients in both perioperative and non-operative settings are urgently needed.

Conflicts of Interest

No potential conflict of interest relevant to this article was reported.

Author Contributions

Avinash Gobindram (Writing–original draft; Writing–review & editing)
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