Scholars Journal of Medical Case Reports
Abbreviated Key Title: Sch J Med Case Rep
ISSN 2347-9507 (Print) | ISSN 2347-6559 (Online)
Journal homepage: https://saspublishers.com

OPEN ACCESS

Anesthesiology & Pain Medicine

High-Flow Nasal Oxygen (Optiflow) 10 L/min Therapy for an Unexpected Desaturation during Awake Craniotomy

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DOI: 10.36347/sjmcr.2023.v11i04.017 | **Received:** 06.03.2023 | **Accepted:** 13.04.2023 | **Published:** 14.04.2023

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Abstract **Case Report**

Providing adequate sedation while ensuring normoventilation is a challenge during an awake craniotomy. The use of sedative agents may cause hypoventilation and apnea, inducing hypoxemia and hypercapnia. High-flow humidified nasal oxygen delivery devices have shown positive results in various clinical areas. Here, we present two case reports of patients undergoing awake craniotomy who experienced a sudden decrease in oxygen saturation while receiving dexmedetomidine sedation. Despite being aroused to take deep breaths, the patients' oxygen saturation did not return to baseline. Arterial blood gas analysis (ABGA) revealed a significant fall in partial pressure of oxygen. To address the hypoxemia, we initiated high-flow nasal oxygen (Optiflow) 10 L/min instead of conventional oxygen treatment via nasal prong. Follow-up ABGA results showed that Optiflow 10 L/min effectively provided adequate oxygenation and prevented the retention of carbon dioxide. Optiflow 10 L/min was successful in managing the patients' hypoxemia while maintaining adequate oxygenation, ventilation, and sedation during awake craniotomy.

Keywords: Awake craniotomy, Optiflow, high-flow nasal oxygen, oxygenation.

INTRODUCTION

Awake craniotomy enables intraoperative brain mapping and avoids potential damage to the motor or the speech areas, allowing maximum tumor resection [1]. Numerous anesthetic strategies are in use; however, the challenge is to maintain adequate sedation and respiration during an awake craniotomy. The possibility of hypoventilation and apnea is always a concern while administering sedative agents. Optiflow™ (Fisher and Paykel Healthcare, Auckland, New Zealand) is a high-flow nasal oxygenation device with active humidification that has been used in different clinical areas. In the present cases, a sudden decrease in oxygen saturation (SpO_2) was observed during dexmedetomidine sedation before the start of surgery. Optiflow 10 L/min was used instead of a conventional oxygen supply device, and we report the benefits of using Optiflow during an awake craniotomy.

CASE DESCRIPTION

Case 1

A 31-year old female with body mass index (BMI) 25.32 (height 152cm, weight 58.5 kg) presented with numbness in her left arm and leg for about a year. She was diagnosed with a 6 cm well-defined tumor in the medial portion of the right cerebrum, suspected to be anaplastic oligodendroglioma. She had no known past history and preoperative lab results were within normal limits. The patient consented to undergo awake craniotomy using monitored anesthesia care technique with scalp block and sedation for neurological function preservation.

Noninvasive monitoring devices were applied to the patient, including ECG, pulse oximetry, and blood pressure, upon arrival in the operating room. The patient's blood pressure was 137/89 mmHg, heart rate 95 beats/min, and SpO_2 was 100% at room air with sinus rhythm on ECG. Dexmedetomidine infusion was started at 0.7 µg/kg/h without a bolus, and direct arterial pressure monitoring via radial artery cannulation was performed. Initial arterial blood gas analysis (ABGA) showed pH 7.401, partial pressure of carbon dioxide ($PaCO_2$) 32.3 mmHg, and partial pressure of oxygen (PaO_2) 89.4 mmHg. After securing more IV lines for volume replacement, scalp block was performed, and the neurosurgeons began their preparations for surgery. However, the patient experienced desaturation with SpO_2 dropping to 88%, despite taking regular breaths

under dexmedetomidine sedation, before the surgery started. The patient was stimulated to wake up and encouraged to take deep breaths, but SpO_2 did not increase above 94%, and a follow-up ABGA showed pH of 7.399, $PaCO_2$ 34.8 mmHg, and PaO_2 54.5 mmHg.

To address the hypoxemia, high-flow nasal oxygenation with humidified oxygen using Optiflow at a flow rate of 10 L/min with nasal cannula was used instead of usual 3 L/min supplemental oxygen via nasal cannula. End-tidal carbon dioxide ($EtCO_2$) was monitored through a side port, and the patient was informed to open her mouth if high nasal flow became uncomfortable. Follow-up ABGA was done to increase the flow of oxygen (O_2) if necessary. The pH 7.416, $PaCO_2$ 34.4 mmHg, PaO_2 392.5 mmHg was observed, and 180 min later, pH 7.465, $PaCO_2$ 33.2 mmHg, PaO_2 483.8 mmHg were noted. $EtCO_2$ was maintained between 28-36 during the surgery, and bispectral index (BIS) was kept between 76-91 during sedation.

Case 2

A 57-year-old male was scheduled to undergo awake craniotomy due to a poorly defined peripheral thick enhancing lesion measuring 4.3 x 3.2 cm in the right frontoparietal lobe. The patient presented with numbness in the perioral area, difficulty moving fingertips, left-side hypoesthesia, and numbness. The patient height was 178 cm tall, weighed 93 kg, had a BMI of 29.35, and a short neck. After applying routine monitoring devices, dexmedetomidine 0.6 µg/kg/h was initiated. Direct arterial pressure monitoring via radial artery cannulation and scalp block were performed. However, the SpO_2 dropped from 99 to 94%. The patient was encouraged to take a deep breath, and dexmedetomidine infusion was reduced to 0.45 µg/kg/h. ABGA revealed pH 7.408, $PaCO_2$ 34.3 mmHg, and PaO_2 70.4 mmHg.

Optiflow at a flow of 10 L/min with nasal cannula was applied to the patient, and he was instructed to open his mouth if a high nasal flow became intolerable. Follow-up ABGA was conducted to determine whether it was necessary to increase the flow of O_2. The ABGA showed pH 7.375, $PaCO_2$ 31.2 mmHg, and PaO_2 342 mmHg. After 150 min, the pH was 7.337, $PaCO_2$ 41.6 mmHg, and PaO_2 369.5 mmHg. $EtCO_2$ was maintained between 27-35, and BIS was between 75-83 during sedation throughout the surgery.

DISCUSSION

During an awake craniotomy, an unexpected decrease in SpO_2 was observed. However, the use of high-flow nasal cannula via Optiflow successfully managed the situation and prevented further desaturation. High-flow humidified oxygenation through nasal cannula is an innovative method of oxygen delivery that has been gradually used in many different clinical areas. It is useful in improving oxygenation in patients with sleep apnea [2], exacerbated obstructive pulmonary disease [3], acute respiratory failure [4], as well as in the intensive care unit [5] and for postoperative care [6].

The Optiflow system is designed to deliver humidified oxygen with a flow rate up to 60 L/min. It reduces dead space by enhancing upper airway clearance and decreasing carbon dioxide (CO_2) rebreathing [7, 8]. The flow-dependent effect of continuous positive airway pressure reduces the work of breathing, and good humidification is an advantage that Optiflow has over conventional oxygen devices. A case report with a patient undergoing an awake craniotomy with sleep apnea used O_2 flow at 30 L/min and achieved a good result [2].

In these cases, we started O_2 flow at 10 L/min and decided to gradually increase the flow if necessary by following PaO_2 on ABGA since patients might complain of discomfort and fail to fall asleep. Also, it is difficult to maintain mouth closed and have 30 L/min O_2 flowing through the nasal cavity. Since reports suggest that effectiveness is impaired by an opened mouth as airway pressure is reduced [9-11], we started at 10 L/min and decided to increase the flow if PaO_2 is insufficient. ABGA results show that 10 L/min O_2 was sufficient for treating patients who had low SpO_2 during sedation.

$EtCO_2$ was continuously monitored using a side port via nasal cannula. $EtCO_2$ was maintained slightly below the normal range throughout the surgery. High gas flows and an opened mouth could inaccurately represent continuous $EtCO_2$ values. However, $PaCO_2$ was maintained slightly lower than normal during sedation. High nasal flow decreases inspiratory resistance and increases expiratory resistance, promoting slow, deep breaths that increase alveolar ventilation [8, 9]. This increase in tidal volume and clearance of nasal dead space explains the reduction in $PaCO_2$ with high nasal flow [8]. The use of sedative agents leads to the possibility of hypoventilation and apnea inducing hypercapnia. In these cases, the decrease in $PaCO_2$ was observed even in sedated patients. Optiflow could provide a protective role in managing an awake craniotomy where avoidance of hypercapnia and preventing intracranial pressure elevation is of paramount importance. A flow of 10 L/min was sufficient; however, the effects of a higher flow rate on $PaCO_2$ values should be further considered.

Compared to conventional nasal prong O_2 supply, Optiflow provide heated and humidified O_2. Conventional nasal O_2 without humidification can cause dryness in the nose, mouth, throat, and respiratory tract, leading to discomfort and pain for the patient [12]. Despite being given 10 L/min of O_2, it was well-tolerated by the patients, and there were no complaints of dryness at the end of the surgery.

Previous reports have focused on high-flow nasal oxygenation using at least 30 L/min. Kumar *et al.*, [2] reported a case in which Optiflow 30 L/min provided good oxygenation for a patient with sleep apnea during an awake craniotomy. Our cases demonstrate that Optiflow 10 L/min was sufficient for patients' oxygenation and prevention of $PaCO_2$ elevation during an awake craniotomy. These patients did not have difficult airways, sleep apnea, or obesity. This may explain why only 10 L/min was sufficient for oxygenation and prevention of hypercapnia in sedated patients undergoing an awake craniotomy.

CONCLUSION

Optiflow at 10 L/min was sufficient for managing patients undergoing awake craniotomy while maintaining adequate PaO_2, $PaCO_2$, and sedation.

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