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CASE REPORT

Intraoperative severe bronchospasm treatment with epinephrine puffing by using the MAD Nasal™ intranasal mucosal atomization device: a case report

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Abstract

Background: Perioperative bronchospasm remains a major concern in patients with asthma regardless of careful preoperative evaluation and management. **Case**: We present the case of a 77-year-old female with a history of asthma who underwent tumor resection under general anesthesia. The initial anesthesia induction and intubation were uneventful, with stable vital signs and normal respiratory parameters. Following an 11-h surgical procedure, during recovery with sevoflurane discontinuation and endotracheal tube suction, the patient developed a severe bronchospasm characterized by elevated airway pressure, decreased end-tidal Carbon dioxide (CO_2) and diminished tidal volume. Initial treatment with albuterol via an endotracheal tube was ineffective. Subsequent administration of nebulized epinephrine (200 μg, 1:10,000) by using a MAD Nasal device promptly alleviated symptoms and improved ventilatory parameters. The patient required postoperative intensive care unit admission for ventilatory support but ultimately recovered without further bronchospasm episodes. This case underscores the unpredictable nature of perioperative bronchospasms and the critical need for preparedness to manage complications effectively. This highlights the potential role of the MAD Nasal™ Intranasal Mucosal Atomization Device as a practical and efficient alternative for delivering critical medications such as epinephrine in the perioperative setting, circumventing the challenges associated with intravenous administration during emergency situations. Enhancing healthcare provider training through structured simulations is essential for optimizing readiness and ensuring prompt intervention in similar clinical scenarios. **Conclusions**: We believe this case report contributes to the growing body of literature emphasizing the importance of tailored management strategies and innovative devices to mitigate the risks associated with perioperative bronchospasms, thereby improving patient outcomes.

Keywords

Asthma; Albuterol; Bronchial spasm; Epinephrine

1. Introduction

Pulmonary diseases such as asthma and chronic obstructive pulmonary disease are common and may cause serious complications during the perioperative period [1, 2]. Further, patients with bronchial asthma may have a higher risk of perioperative bronchospasms and laryngospasms than those without asthma [1, 3]. Thus, patients with pulmonary diseases must be carefully evaluated and managed appropriately before anesthesia. Despite these measures, severe bronchospasms may develop during the perioperative period, and preparations must be in place to address this issue [1, 3, 4]. Here, we report a case of a severe bronchospasm during the recovery phase after general anesthesia in a 77-year-old woman with a history of asthma, along with a brief review of the literature.

2. Case report

A 77-year-old woman (American Society of Anesthesiologists Class II; weight, 60.6 kg; height, 149.2 cm; nonsmoker) with a squamous cell carcinoma on the right lower gum was scheduled to undergo tumor resection and reconstruction with a free flap. The patient had been treated for hypertension and bronchial asthma. Her pulmonary function test results were normal, and she used a salbutamol metered-dose inhaler if symptoms developed. The pulmonology department was consulted, and ipratropium bromide and salbutamol nebulizer use was recommended if asthma symptoms developed during the perioperative period. Preoperative laboratory findings were normal, with a hemoglobin level of 12.2 mg/dL, hematocrit of 35.3% and a platelet count of 323,000 μL. Electrocardiography

and chest radiography results were unremarkable.

After she was brought to the operating room, patient monitoring systems, including those for electrocardiography, continuous blood pressure (BP), pulse oximetry, bispectral index, central venous pressure, and continuous arterial BP with radial artery catheter insertion, were instituted. Her initial vital signs were as follows: BP, 131/75 mmHg; heart rate (HR), 87 beats/min; and respiratory rate, 23 breaths/min. Dexamethasone 5 mg was intravenously injected before anesthesia induction.

General anesthesia was induced with intravenous injection of 1 mg/kg lidocaine, 0.1 mg/kg remimazolam and 0.6 mg/kg rocuronium, followed by maintenance with 4% sevoflurane. Nasotracheal intubation was performed using direct laryngoscopy, and a 6.0-mm ivory right-angled tube (Polar™ Preformed Tracheal Tube, Smith Medical, MN, USA) was inserted. Bilateral breath sounds were intact without wheezing sounds. Volume control ventilation was initiated with an inspiratory oxygen fraction of 0.5, a tidal volume of 450 mL, a respiratory rate of 10/min, and peak end-expiratory pressure of 5 cmH_2O. The peak airway pressure was 19 cmH_2O. The results of the initial arterial blood gas analysis (ABGA) were normal (pH: 7.393, arterial oxygen partial pressure: 220 mmHg, arterial CO_2 partial pressure: 42.3 mmHg, arterial bicarbonate: 24.9 mmol, and base excess: −0.3 mmol). A central venous catheter (7F triple lumen) was inserted into the right femoral vein under ultrasonographic guidance.

Tumor resection, modified radical neck dissection, and reconstruction surgery were performed, which took 11 hours and 45 minutes. At the conclusion of the surgery, sevoflurane was discontinued and the patient was ventilated with 100% oxygen at 2130 hours. Endotracheal tube suctioning was performed. Immediately after endotracheal suction, the airway pressure increased from 23 to 35 cmH_2O and end-tidal CO_2 decreased from 33 to 5 mmHg at 2132 hours. The tidal volume was very low (30–50 mL). Vital signs were as follows: BP 112/73 mmHg, HR: 100 beats/min, oxygen saturation 98%. There were no symptoms of allergy or anaphylaxis like skin rash, airway edema and cardiovascular collapse. Mechanical ventilation was switched to manual ventilation, and the tidal volume was 50–82 mL when the peak pressure was approximately 40 cmH_2O and a wheezing sound was noted in both whole lung fields. Development of a bronchospasm was considered, and an albuterol metered-dose inhaler was puffed directly into the endotracheal tube thrice and the patient was manually ventilated at 2135 hours. Dexamethasone (5 mg) was administered intravenously. Sevoflurane 4% was administered to increase the anesthetic depth. However, albuterol treatment was ineffective and was repeated two more times (three puffs each time); however, this intervention was also ineffective (2137 hours). At the time, her BP was 140/80 mmHg and HR was 98 beats/min. Epinephrine 200 μg (1:10,000) was puffed directly into the endotracheal tube by using the MAD Nasal™ Intranasal Mucosal Atomization Device (Teleflex, Atomization, Morrisville, NC, USA), after which the symptoms immediately improved (Fig. 1). The tidal volume and peak inspiratory pressure returned to 410 mL and 20 cmH_2O, respectively. Her oxygen saturation decreased to 88% but recovered shortly after normal ventilation was confirmed. Vital signs were as follows: BP 112/73 mmHg, HR: 100 beats/min, there was no sharp increase of blood pressure after epinephrine puff. Then, the patient was transferred to the intensive care unit (ICU) for nasotracheal intubation. She was extubated on the third postoperative day (POD) but was re-intubated owing to dyspnea with deoxygenation. On POD 9, her pulmonary symptoms improved and she was extubated. No bronchospasms were noted during this period. The patient was transferred to the general ward on POD 10 and was discharged without complications on POD 25.

FIGURE 1. MAD Nasal™ intranasal mucosal atomization device.

3. Discussion

Various conditions, including chronic obstructive pulmonary disease, bronchial asthma, anaphylaxis, hypersensitivity to antibiotics and obesity, may induce perioperative bronchospasm [3, 5]. Severe bronchospasm-induced inadequate ventilation can precipitate life-threatening or potentially fatal complications that resemble irreversible brain injury [3].

The literature recommends that patients should be thoroughly evaluated and their condition appropriately managed with suitable medications before undergoing general anesthesia. Among surgical patients, those with uncontrolled asthma have twice the mortality rate and three times the incidence of postoperative pneumonia [3]. However, in patients with well-controlled asthma, the incidence of severe complications is notably low, with a probability of less than 2% [3]. This involves preoperative evaluations (including medical history, physical examinations, chest radiography, electrocardiography and pulmonary function tests), appropriate perioperative medications and vigilant maintenance of anesthesia.

Despite these efforts, bronchospasms may still develop, necessitating preparedness for managing such situations [6]. Amao *et al.* [6] reported two cases of anaphylaxis, both of which occurred during recovery from general anesthesia with desflurane. If a bronchospasm is suspected, the patient should be manually ventilated with 100% oxygen and stimulation should be stopped [7]. The possibility of a severe allergic

reaction or anaphylaxis should be evaluated. If a patient is intubated, the tube position should be checked to exclude blocked or misplaced tubes or breathing circuits. The first-line drug used is salbutamol (6–8 puffs administered into the endotracheal tube directly by using a metered-dose inhaler, or intravenous injection of 250 μg slowly followed by that of 50–200 μg/min). If this intervention is ineffective, interventions such as the administration of second-line drugs including corticosteroids, deepening of anesthesia with volatile or intravenous anesthetics, magnesium sulfate usage and intravenous injection of nebulized epinephrine are performed (Table 1).

In our case, the administration of salbutamol thrice (three puffs each time) was ineffective. Dexamethasone 5 mg was administered at the beginning of surgery and 50 min before the end of surgery; however, a bronchospasm could not be prevented. The literature recommends removing the tube under deep sedation; however, given our patient's well-controlled asthma, it was deemed prudent to allow her to recover in the usual manner, weighing the risks and benefits. Nonetheless, a bronchospasm developed during tube suctioning with sevoflurane reduced to 1–2%, and the patient was in a state of reversed neuromuscular blockade. Albuterol is the first-line treatment for acute bronchospasms; however, it was ineffective in our case. Among the second-line treatments, epinephrine was the most readily available. However, the patient's elevated blood pressure (140/80 mmHg) and HR (98 beats/min) posed a risk of significant hypertension and myocardial ischemia. Thus, we administered nebulized epinephrine (200 μg, 1:10,000) directly into the endotracheal tube by using the MAD Nasal device, and this intervention was successful. This device is simple and easy to use and can nebulize various medications. Although it is designed for intranasal drug nebulization, it effectively delivered the medication through an endotracheal tube. Epinephrine is an important medication for the treatment of severe allergic reactions [8]. However, according to the emergency medicine literature, approximately 24% of epinephrine administrations are inappropriate, and such errors can lead to life-threatening complications, including transient severe systolic dysfunction, cardiac ischemia or infarction, tachydysrhythmia and labile hypertension [9].

Wang *et al.* [9] reported errors when performing a treatment simulation for a severe allergic-like contrast reaction. They conducted a study involving 40 radiologists, who participated in a structured, high-fidelity scenario that simulated a severe allergic reaction. Participants committed one or more errors in 58% of the cases. In this study, epinephrine was administered only when there was no response to oxygen or albuterol. However, 43% of patients were administered epinephrine in situations where it was not indicated. Errors included epinephrine administration instead of that of a first-line drug (albuterol through a metered-dose inhaler), additional epinephrine use without waiting for 5 min to assess the effect of epinephrine, and administration of subsequent doses before ensuring an adequate intravenous catheter flush. Furthermore, cases of administering subcutaneous doses intravenously and *vice versa* were frequently noted, along with the use of incorrect dosages and concentrations for intravenous administration versus subcutaneous injection. The researchers recommend reducing such dosing errors by labeling prefilled syringes with appropriate usage indications (*e.g.*, "for anaphylaxis only" and "for CPR (Cardiopulmonary resuscitation) only"). From this perspective, the use of the MAD Nasal device for epinephrine nebulization is deemed advantageous because of its perceived safety compared with intravenous injection as well as its independence from specialized nebulizer equipment.

This case report has several limitations. First, as a single case, it cannot establish a causal relationship between the interventions and clinical outcomes. Second, while nebulized

TABLE 1. Management of acute intraoperative bronchospasm.

Treatment options
1. Initial procedures:
(a) Manual ventilation with 100% O_2
(b) Ruling out of obstruction or kinking of the endotracheal tube and breathing circuits (consider chest radiograph)
(c) Stoppage of stimulation including surgical procedures
(d) Consider anaphylaxis and allergic reactions, stop administration of suspected materials
2. Pharmacologic treatment
1st line drug therapy: Administration of 3∼4 puffs of albuterol by using a metered-dose inhaler
2nd line drug therapy:
(a) Deepening of anesthesia with volatile or intravenous anesthetics
-Propofol 1–2 mg/kg
-Ketamine: bolus dose (0.5–1 mg/kg), 0.5–1 mg/kg infusion after the bolus dose
(b) Intravenous epinephrine administration: bolus dose (1–2 µg/kg) and infusion (0.02–0.1 µg/kg/min)
(c) Magnesium administration: bolus dose (25–50 mg/kg) and infusion (10–20 mg/kg/h)
(d) Corticosteroid administration (if not administered previously)
(e) Aminophylline administration: 3–5 mg/kg loading over 20 min and 0.5 mg/kg/h infusion

O_2: oxygen.

epinephrine via the MAD Nasal™ device was effective in this case, its use through an endotracheal tube has not been extensively validated, and its broader efficacy and safety remain uncertain. Further studies comparing the effectiveness of conventional nebulizers and the MAD Nasal™ device, even outside of emergency settings, are needed to better validate this method.

In conclusion, we report a case of a severe bronchospasm that led to ventilatory failure. The bronchospasm developed despite meticulous preoperative and intraoperative management. Appropriate medications and equipment must be ensured to manage such situations. In addition, regular training using well-designed simulations is necessary. Epinephrine serves as an option when albuterol proves ineffective; however, caution is warranted because of its potential to cause serious side effects and its infrequent use, which increases the likelihood of errors. A systematic approach is required to prevent such errors, and the MAD Nasal device represents a potential avenue for mitigating these risks.

ABBREVIATIONS

CO_2: Carbon dioxide; BP, blood pressure; HR, heart rate; ABGA, arterial blood gas analysis; ICU, intensive care unit; POD, postoperative day; O_2: oxygen; CPR: Cardiopulmonary resuscitation; IRB, institutional review board.

AVAILABILITY OF DATA AND MATERIALS

All data generated or analyzed during this work are included in this article and its supplementary information files. Further information was obtained from the corresponding author upon reasonable request.

AUTHOR CONTRIBUTIONS

SMJ and YSY—reviewed patient records and collected the data. JS and MAK—wrote the manuscript. All authors contributed to editorial changes to the manuscript. All authors read and approved the final manuscript.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Institutional Review Board (IRB) approval was obtained from the IRB of Dankook University Hospital (DKUH 2024-7-005). Written informed consent was obtained from the patient for the publication of this report in accordance with the journal's patient consent policy.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

REFERENCES

[1] Renew JR, Aniskevich S. Perioperative pulmonary medication management. Current Clinical Pharmacology. 2017; 12: 182–187.

[2] Anderson N, Clarke S, von Ungern-Sternberg BS. Aerosolized drug delivery in awake and anesthetized children to treat bronchospasm. Paediatric Anaesthesia. 2022; 32: 156–166.

[3] Bayable SD, Melesse DY, Lema GF, Ahmed SA. Perioperative management of patients with asthma during elective surgery: a systematic review. Annals of Medicine and Surgery. 2021; 70: 102874.

[4] Chandler D, Mosieri C, Kallurkar A, Pham AD, Okada LK, Kaye RJ, *et al*. Perioperative strategies for the reduction of postoperative pulmonary complications. Best Practice & Research Clinical Anaesthesiology. 2020; 34: 153–166.

[5] Maddah SA, Barzegari A. The effect of albuterol spray on hypoxia and bronchospasm in patients with chronic obstructive pulmonary disease (COPD) under general anesthesia: a bouble-blind randomized clinical trial. Ethiopian journal of health sciences .2023; 33: 491–498.

[6] Amao R, Zornow MH, Cowan RM, Cheng DC, Morte JB, Allard MW. Use of sugammadex in patients with a history of pulmonary disease. Journal of Clinical Anesthesia. 2012; 24: 289–297.

[7] Khara B, Tobias JD. Perioperative care of the pediatric patient and an algorithm for the treatment of intraoperative bronchospasm. Journal of Asthma and Allergy. 2023; 16: 649–660.

[8] Liu T, Hong Y, Peng Y, Lu Y, Cao L. Successful adrenaline treatment of perioperative severe bronchospasm combined with a silent lung: two case reports. Translational Cancer Research. 2022; 11: 1445–1450.

[9] Wang CL, Davenport MS, Chinnugounder S, Schopp JG, Kani K, Zaidi S, *et al*. Errors of epinephrine administration during severe allergic-like contrast reactions: lessons learned from a bi-institutional study using high-fidelity simulation testing. Abdominal Imaging. 2014; 39: 1127–1133.

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