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Failed Ventilation Immediately after Skin Incision during General Anesthesia with a Laryngeal Mask Airway

ABSTRACT

Ventilation difficulty during general anesthesia via laryngeal mask airway (LMA) has been a subject of debate since its developments. Here, we present a patient who experienced difficulty of ventilation immediately after initial skin incision followed by a period of sufficient ventilation. The difficulty of ventilation was not relieved by positive pressure ventilation or propofol injection. Ventilation recovered after administration of rocuronium. We assumed that closure of the vocal cords caused a sudden obstruction of the airway and that subsequent administration of a neuromuscular blocking agent restored airway patency by opening a closed vocal cord. This case report may support the potential importance of neuromuscular blocking agents for management and prevention of difficult ventilation that may occur with LMA.

Keywords: Laryngeal Mask Airway; Ventilation Difficulty; Airway Obstruction.

ABBREVIATIONS:

LMA: Laryngeal Mask Airway; FMV: Face-Mask Ventilation; ETT: Endotracheal Tube

INTRODUCTION

Laryngeal mask airways (LMAs) are an airway device developed in 1988 as an alternative to endotracheal tube (ETT) placement and face-mask ventilation (FMV) [1]. With the development of second generation laryngeal masks, there has been a continuous increase in both frequency of use and areas of application [2]. Recent studies have validated the safety and effectiveness of LMAs for various types of surgeries requiring special considerations with respect to duration, position, surgical factors, and patient factors that were previously considered to be barriers to LMA use. However, despite the fact that LMAs are becoming more popular and have distinct advantages over ETT and FMV devices [3], LMA failure remains a constant subject of debate since its development, as it is estimated to occur in 1.1% of an adult population, resulting in adverse respiratory complication [4].

Here, we report a case of failed ventilation immediately after the first skin incision that was not relieved by positive pressure ventilation or propofol injection, but was finally resolved after injecting low dose rocuronium, resulting in restoration of normal ventilation.

CASE REPORT

A 56-year-old female patient (Height, 158 cm; weight, 72 kg; BMI, 28.8; American society of anesthesiologists' physical status II) was scheduled to undergo surgery for removal of implanted devices on her radius. The preoperative evaluation was unremarkable and examination showed a Mallampati classification II airway with good range of motion of the neck. Prior to surgery the patient was fasted for more than 8 hours and 0.5 mg of atropine sulfate with 2 mg of midazolam was injected intramuscularly just before transfer to the operating room. Standard monitoring was initiated. After preoxygenation, anesthesia was induced with 1% lidocaine 50 mg, propofol 80 mg, rocuronium 20 mg and a continuous infusion of Remifentanil (2 µg/kg/h) with sevoflurane as a maintenance agent. A size-3 LMA i-gel (Intersurgical Ltd, Wokingham, UK) was inserted with a standard method and the ventilation monitor exhibited a normal capnograph with adequate airway pressure. The ventilator (Flow-i, Maquet, Solna, Sweden) was set to pressure regulated volume control mode with a tidal volume adjusted to 450 ml with a rate of 12 breaths per minute and positive end expiratory pressure of 5 mm H₂O. The end tidal sevoflurane was set to 1.9 percent with continuous remifentanil infused at a rate of 0.1 µg/kg/min prior to initial incision. The BIS score showed deep anesthesia.

Immediately after skin incision there was sudden failure of ventilation with absence of capnography on the ventilation monitor. The ventilator was changed to manual ventilation, and total airway obstruction was felt manually with high airway pressure failing to ventilate the patient. Next, 40 mg of propofol was injected and the ventilator was changed to an inspired oxygen fraction (FiO₂) of 100% and inspired sevoflurane concentration (FiSevo) to 3.4%; however, the obstruction did not subside until saturation of the arterial oxygen began to drop to 95%. We then immediately administered 20 mg of rocuronium. After 30 seconds, ventilation started to work and normal capnography appeared with saturation of pulse oximetry from 89% to 100%. These events together took a total of 140 seconds. At the end of the surgery, spontaneous ventilation was restored. Neostigmine 2 mg and glycopyrrolate 0.4 mg was given as the reversal agent. The LMA was removed after the patient showed voluntary movements and began to open their eyes. The patient was transferred to the post-anesthesia care unit for 30 minutes of recovery, followed by transfer to the general ward.

The entire operation took 70 minutes and the patient's vital signs were stable throughout anesthesia. The patient was discharged without anesthetic complications.

DISCUSSION

Ventilatory difficulty during general anesthesia with an LMA has been reported in several studies, and the causes and adequate management of LMA complications have not been fully established [4]. Initial failure of adequate ventilation can be explained by incomplete seal of the cuff on the laryngeal surface, epiglottis folding, and foreign bodies and masses obscuring the glottis. There have also been cases of closed vocal cords visually confirmed, in which sudden or gradual elevation of ventilatory resistance occurred after normal ventilation for a short period of time [5,6].

The ventilatory difficulty in the case reported here occurred suddenly at a time of strong stimulus that was accompanied by signs of complete airway obstruction with unyielded tidal volume and absence of end tidal CO₂. Although it would have been beneficial if the obstructed airway had been confirmed visually with a fiberoptic bronchoscope, failed ventilation is an emergent situation that requires prompt treatment. Although disruption of the LMA cuff seal was considered as a possible cause of airway obstruction, this was considered unlikely given the patients lack of voluntary movement and strong fixation of the LMA around the patient's lips with two long thick plasters. Thus, laryngospasm was deemed to be the most probable cause of the sudden airway obstruction, and we initiated management focusing on trying to open the closed vocal cord based on this presumed diagnosis.

In previously reported cases of visually confirmed closure of the vocal cord during anesthesia via LMA, either deepened anesthesia with propofol [6] or deepened neuromuscular blockade with atracurium [5] has been shown to open closed vocal cords. In contrast, Thomas et al., [7] reported a series of 12 cases in which additional administration of propofol or remifentanil did not effectively improve ventilation during laryngospasm. In that series, normal ventilation was restored with disappearing high pitched sounds only after rocuronium was given. Our experience with this case was similar. Thus, taken together, our findings may support the superiority of the first using a neuromuscular blocker for suspected vocal cord closure. In doing so, the closed vocal cord can open effectively at a specific time and, to some extent, in a predictable manner [8].

The minimum effective dose of neuromuscular blocker needed for relieving adducted vocal cords has not yet been established. In our case, 20 mg of rocuronium was effective. In another study, 0.2 mg of atracurium was effective, in which the TOF count was 3 at the time of vocal cord opening [5]. Another study showed that rocuronium (0.15 mg/kg) was sufficient to alleviate airway resistance within three minutes [7]. Although it is probable that a less than complete neuromuscular blockade is sufficient for opening a closed vocal cord, patients with a lower oxygen reserve or cardiopulmonary disease require a higher dose of rapid onset neuromuscular blocker, which might be a safer method to rapidly relieve obstruction.

As the safety time of apnea to desaturation for appropriate management during laryngospasm is only a few minutes, novice residents or practitioners not familiar with using an LMA may benefit by using a sufficient amount of neuromuscular blocker throughout anesthesia, which can facilitate both ease of insertion of LMAs and adequate ventilation throughout surgery with respect to lowering the airway pressure and preventing fatal laryngospasm [9]. Furthermore, there is accumulating evidence that neuromuscular block facilitate mask ventilation and eases tracheal intubation. Thus, there may in fact be no reason to hesitate using neuromuscular blocker unless other contraindications exist [10].

Risk factors for laryngospasm have been the subject of anesthesia research for many years. Numerous patient, surgical, and anesthetic related factors in combination increase the risk of laryngospasm [11]. Among these factors, insufficient depth of anesthesia and strong stimulus has long been recognized as the most prevalent causes of laryngospasm. In addition, high doses of opioids precipitate vocal cord closure [12], and mechanical forces applied to larynx by LMA can opened these vocal cords even in paralyzed patients [13]. Although previous studies have been performed mostly in intubated patients and little information is available regarding prevention of laryngospasm when using an LMA, further studies are needed to elucidate the movement of the vocal cords during anesthesia with an LMA.

CONCLUSION

In conclusion, preventing laryngospasm during general anesthesia, despite adequate depth, requires paying special attention at the time of a strong stimulus, especially the first skin incision during general anesthesia with an LMA. The

case reported here may support the potential usability of neuromuscular blockers for managing and preventing difficult ventilation when using an LMA.

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