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The Usefulness of Rocuronium and Sugammadex in the Anesthetic and Surgical Management of an Infant with Large Mediastinal Mass: A Case Report

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Authors' contributions

This work was carried out in collaboration between all authors. Authors GEY and BGL performed anesthetic management of the patient, contributed to conception and design of this report, analysis and interpretation of data, drafting and proofreading the manuscript and made figures. Author ML performed acquisition of data, provided interpretation of data and managed the literature searches. All authors read and approved the final manuscript.

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Case Report

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ABSTRACT

Pediatric patients with large mediastinal mass are in danger of having critical respiratory and hemodynamic problems during anesthetic and surgical process. Traditionally, the key to the success of anesthetic management in pediatric patients with mediastinal mass is to keep spontaneous respiration without administration of muscle relaxants during the whole anesthetic period. Nevertheless, spontaneous respiration may interfere with fine important surgical procedures compared to mechanical ventilation. We hypothesized that a new anesthetic strategy using rocuronium and sugammadex might facilitate mechanical ventilation and surgical procedures, and provide complete and fast recovery of neuromuscular and respiratory function without respiratory complication. Here, we present an infant with severely compressed airway due

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to large mediastinal mass successfully managed with a special anesthetic strategy including use of rocuronium and sugammadex for effective and safe neuromuscular blockade and recovery, and supportive use of a fiberoptic bronchoscope for securing the airway.

Keywords: Airway obstruction; infant; mediastinal mass; neuromuscular blockade; rocuronium; sugammadex.

1. INTRODUCTION

Children with mediastinal mass may be in danger of having the important intrathoracic structures compressed in the mediastinum during the anesthetic process, especially when the changes of dynamic airway pressure occur at the onset of anesthesia [1,2]. In these situations, the maintenance of spontaneous respiration at a perioperative period should be primarily considered as a preventive method for possible critical respiratory complications, especially in patients at high risk [2-4]. However, spontaneous respiration may induce irregular and frequent movement of the thoracic cage, interfering more with fine surgical procedures than mechanical ventilation. This problem may be amplified in smaller pediatric patients, including neonates or infants. Hence, if mediastinal mass is removed imperfectly, a remnant mass may cause airway obstruction after surgery. In addition, supply of deeper anesthesia without muscle relaxant, to maintain spontaneous respiration, may induce critical respiratory complications in the recovery room [5].

For these reasons, we practiced surgical anesthesia in an infant with large mediastinal mass around the trachea with a special anesthetic strategy based on the three key points: 1) maintenance of spontaneous respiration only during anesthesia induction including endotracheal intubation, 2) providing adequate muscle relaxation during the operation, after avoiding the collapse of the trachea with a wire-reinforced endotracheal tube placed just above the carina using a fiberoptic bronchoscope, and 3) safe extubation based on the results of train-of-four (TOF) monitoring following complete and rapid reversal of neuromuscular blockade (NMB) by sugammadex administered just after surgery.

2. CASE REPORT

A 12-month-old female patient (weight: 9.4 kg; height: 78 cm) with known large mediastinal mass visited our hospital for mediastinal mass excision. One month earlier, she had an anoxic seizure caused by airway collapse due to the mediastinal mass. She had been admitted to a neonatal intensive care unit, with ventilator care for a day until the airway collapse was relieved after fine needle aspiration. Although no respiratory collapse manifested again after aspiration, severe tracheal deviation remained (Fig. 1), and, thus, surgical treatment was required.

A computed tomography revealed the rightward tracheal deviation caused by a large cystic mass (Fig. 2). Her lung sound was clear, without stridor or hoarseness, and the vocal cords were intact on the laryngoscope view (Fig. 3).

Prior to the surgery, the surgeons and anesthesiologists fully discussed to make an optimal plan to facilitate surgical procedures and minimize anesthetic risks.

The planned strategies for anesthesia induction were to perform anesthesia induction with intravenous administration of fentanyl and midazolam, without muscle relaxant in order to maintain spontaneous respiration, and to use a video laryngoscope for rapid and smooth endotracheal intubation.

After arriving at the operation room, pulse oximetry, electrocardiography, noninvasive blood pressure, capnography, and state entropy (S/5 Entropy Module, M-ENTROPY, Datex-Ohmeda, Helsinki, Finland) were monitored. The patient's neuromuscular function was checked at the right adductor pollicis muscle, using a TOF monitor (TOF-watch SX®, Organon, Dublin, Ireland). The peripheral arterial oxygen saturation level was 100%. Following preoxygenation for 5 min, anesthesia was induced with 10 μg (1.1 μg/kg) fentanyl and 2 mg (0.2 mg/kg) midazolam. The patient's airway was well maintained by spontaneous ventilation. After decrease of the state entropy to 40, endotracheal intubation was attempted with a video laryngoscope (McGrath® MAC, Aircraft Medical, Edinburgh, United Kingdom). Intubation was successful, with intubation grade 2 (until here, strategy point #1).

Thereafter, we performed flexible fiberoptic bronchoscopy to determine the proper location to

the wire-reinforced endotracheal tube (Internal dimension 4 mm, Mallinckrodt™ Lo-Contour Oral/Nasal Cuffed Tracheal Tube, Covidien, Tullamore, Ireland) [6]. We found a narrowed tracheal wall between the tip of the tube and the carina, using a fiberoptic bronchoscope (LF-P Intubation fiberscope, Olympus, Tokyo, Japan). Under bronchoscopic guidance, the tube was inserted over the narrowed portion of the trachea, and the tube's tip was located just above the carina. The insertion depth of the tube was about 12.5 cm. Then, sevoflurane 2.5 vol% and 50% air in oxygen were used to maintain anesthesia, and 6 mg (0.6 mg/kg) rocuronium (Esmeron®, MSD, Brussels, Belgium) was administered, and a maximum block of T1 height of a TOF stimulus was achieved at 1.5 min after administration of rocuronium. Mechanical ventilation was performed with a tidal volume of 75 ml and a respiratory rate of 20 breaths/min. Peak inspiratory pressure was around 14 cmH_2O (until here, strategy point #2).

During the surgery, sevoflurane was adjusted to maintain state entropy values of 40–60. Anesthesia lasted for 165 min and vital signs were stable. When TOF count was 2, 70 min after the initial administration of rocuronium, 3 mg (0.3 mg/kg) rocuronium was additionally administered. TOF count was 0 to 1 for 40 min after the first additional dose. When the operation was successfully completed, 150 min after anesthesia induction, TOF count was 3. At that moment, 20 mg (2.1 mg/kg) sugammadex (Bridion®, MSD, Oss, The Netherlands) was administered intravenously, and all anesthetics were stopped. Prior to anesthesia, a written informed consent was obtained from the patient's mother for the use of sugammadex as an off-label drug use in pediatric patients less than 18 years in the Republic of Korea. The time to reach

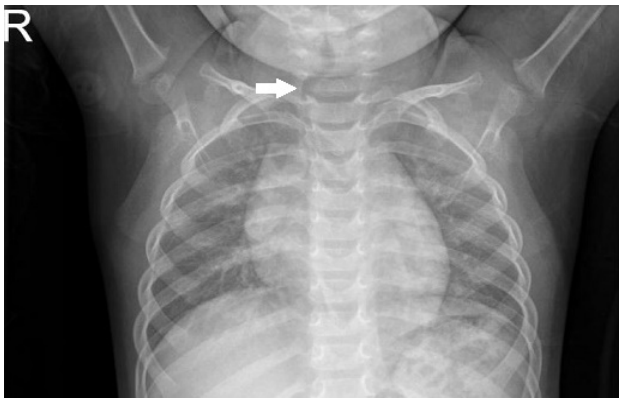

Fig. 1. Preoperative chest X-ray. The rightward tracheal deviation was observed before the surgery (white arrow)

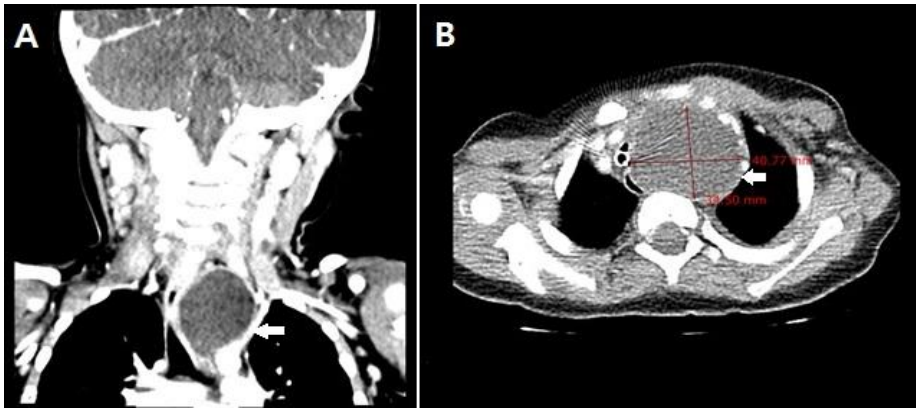

Fig. 2. Preoperative computed tomography (CT) scan. A: Coronal section. The CT image shows that the tracheal lumen is severely compressed and narrowed by a large cystic mediastinal mass (white arrow). B: Axial section. The CT image shows about 4.0 x 3.5 x 3.8 cm-sized anterior cystic mediastinal mass (white arrow)

a TOF ratio of 0.9 was 140 sec from the administration of sugammadex. After approximately 4 min, the patient was able to breathe spontaneously and regularly. After 8 min, eye opening occurred, and, thus, the trachea was extubated. Upon arrival at the recovery room, her muscle power was good and she had no respiratory or hemodynamic problem. She had no symptoms associated with residual NMB during the 24 hours of postoperative period (until here, strategy point #3).

On the postoperative chest X-ray, tracheal deviation was absent (Fig. 4). The patient was discharged 3 days after the surgery, without any complications.

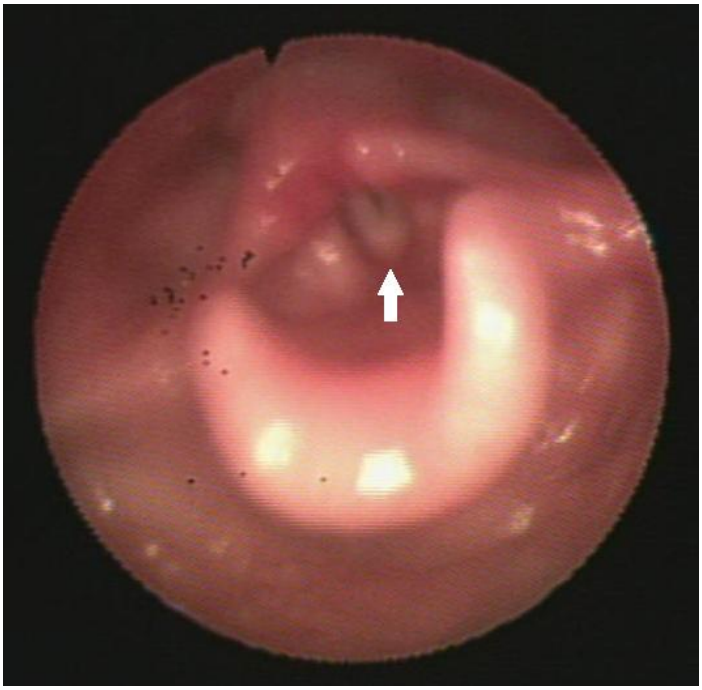

Fig. 3. Preoperative laryngoscopic examination. The vocal cords are intact and easily visible (white arrow)

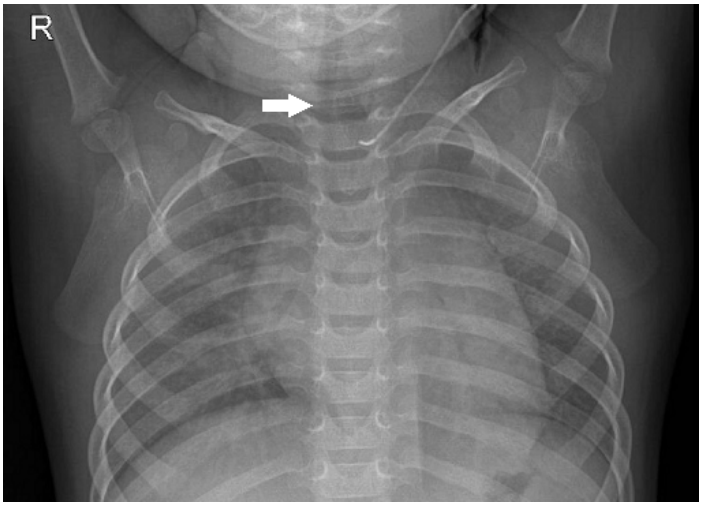

Fig. 4. Postoperative chest X-ray. Tracheal deviation was absent after the surgery (white arrow)

3. DISCUSSION

A recent study suggested that the maintenance of spontaneous respiration during anesthesia and surgery is still important in pediatric patients with mediastinal mass, but if muscle paralysis is mandatory for surgical procedures in the patients, it should be started with an ultrashort-acting muscle relaxant such as succinylcholine to confirm that the patient can bear positive-pressure ventilation before using longer-acting muscle relaxants [2]. However, currently, succinylcholine is recommended to be avoided to use in pediatric patients because of its many problems or complications, while newer nondepolarizing muscle relaxants, particularly rocuronium can provide the benefits of succinylcholine without its severe adverse effects [7]. Although there remains a concern about the occurrence of postoperative residual NMB by more prolonged action of rocuronium-induced NMB, sugammadex, a novel potent reversal agent for rocuronium-induced NMB, can reduce the incidence of residual NMB markedly and facilitate rapid and safe postoperative recovery [8]. There have been numerous studies, reviews and meta-analyses about the effectiveness and safety of sugammadex in pediatric patients including infants [9-15].

Considering these anesthetic issues and surgical issues including the need of complete resection of the mass and surgical convenience, the surgeons and anesthesiologists fully discussed before performing the surgery. Acker et al. [16] also emphasized the importance of preoperatively establishing a multidisciplinary plan to safely manage these pediatric patients. Through the discussion, we devised a special anesthetic plan focused on the three strategy points for this challenging case: 1) maintenance of spontaneous respiration by inducing anesthesia without muscle relaxants; 2) providing adequate muscle relaxation following the evasion of tracheal collapse, with a wire-reinforced endotracheal tube placed just above the carina, using a fiberoptic bronchoscope, and 3) complete reversal of NMB by sugammadex at the end of surgery.

As for point #1, we used the method presented in previous reports [1-4]. Its objective was to perform intravenous anesthesia induction with fentanyl and midazolam, without muscle relaxant to maintain spontaneous respiration, and to perform rapid and smooth endotracheal intubation using a video laryngoscope.

The aim of point #2 was to place the endotracheal tube in a proper location using a flexible fiberoptic bronchoscope. The authors had performed this bronchoscopic management with a similar purpose in adolescent patients with Duchenne muscular dystrophy [6]. The present patient had a history of a hypoxic event that had been caused by a mediastinal mass located at about 2 cm above the carina. If the trachea had been compressed more than 50% of its diameter like this case, the patient would have been at high risk of critical airway complications after anesthesia induction [17]. Therefore, we made a wire-reinforced endotracheal tube passed over the narrowed portion of the trachea, under bronchoscopic guidance, and kept the tube's tip located just above the carina. Through this management, the risk of the tracheal collapse could be overcome, and NMB and mechanical ventilation could be provided to the patient. In addition, we closely observed the monitoring signs, including airway pressure and capnogram that could warn of an incident of unwanted one-lung ventilation throughout the surgery. The surgeon was satisfied with the operating conditions and performed the surgical procedure successfully.

After the surgeon had confirmed that the mass had been completely removed and the trachea had been restored to the original shape and position, we moved on to point #3. The objectives were to completely restore the muscle power and respiration of the patient without any residual NMB and to safely perform extubation based on the results of TOF monitoring, which required the administration of sugammadex. The recommended dose of sugammadex in neonates, infants, and children is 2 mg/kg, to reverse a moderate block [18]. Plaud et al. [19] also described that the effect of sugammadex in pediatric patients including infants, children, and adolescent patients was reliable and tolerable with 2 mg/kg sugammadex. Thus, we administered 2 mg/kg sugammadex based on the TOF count 3 at the end of surgery, after we had provided adequate NMB using rocuronium under appropriate neuromuscular monitoring throughout the surgery. After we had confirmed that the TOF ratio reached 0.9 in 140 sec after administration, the patient was extubated safely [15,20] and showed no symptoms or signs of residual NMB.

4. CONCLUSION

We successfully performed surgical anesthesia using a new special anesthetic strategy in an

infant with the severely compressed trachea due to large anterior mediastinal mass. This strategy consists of the maintenance of spontaneous respiration during anesthesia induction combined with special airway intervention, using a wire-reinforced endotracheal tube and a fiberoptic bronchoscope, together with providing rocuronium-induced NMB during the surgery and complete reversal of NMB by administration of sugammadex at the end of surgery, and safe extubation based on the values of TOF monitoring.

Therefore, we suggest that our new anesthetic strategy using rocuronium-induced NMB followed by its complete reversal with sugammadex might facilitate both mechanical/positive-pressure ventilation and fine surgical procedures, while keeping the patient's ventilatory and hemodynamic status stable during the surgery and postoperative period.

CONSENT

As per international standard or university standard, written consent obtained from the patient's mother has been collected and preserved by the authors.

ETHICAL APPROVAL

It is not applicable.

DISCLAIMER

This manuscript was presented in part at the E-Poster Presentations Session in the 93rd Annual Scientific Meeting of the Korean Society of Anesthesiologists, which took place in Incheon, South Korea, Nov 3–5, 2016.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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