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Case Report

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Sugammadex for Rapid Intraoperative Reversal of Neuromuscular Blockade in a Neonate

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Abstract

Sugammadex is a novel pharmacologic agent for the reversal of neuromuscular blockade, which selectively encapsulates the neuromuscular blocking agent (NMBA) thereby effectively removing it from the plasma concentration. In contrast to acetylcholinesterase inhibitors, sugammadex is able to reverse even profound neuromuscular blockade occurring immediately after the administration of a NMBA. Given this clinical effect, it has been suggested for use in critical clinical situations where rapid reversal of neuromuscular blockade is required. We report the use of sugammadex to reverse neuromuscular blockade following difficulty with positive pressure ventilation after endotracheal intubation in a neonate with a tracheoesophageal fistula. The potential for its use in critical airway and ventilation scenarios is reviewed.

Keywords: Sugammadex; Cannot intubate-cannot ventilate; Functional airway obstruction; Neonate

Introduction

Sugammadex (Bridion®, Merck & Co, Whithouse Stations, New Jersey) is a novel pharmacologic agent for the reversal of neuromuscular blockade, which was approved for clinical use in the United States by the Food and Drug Administration (FDA) in December 2015. It is a synthetically modified γ-cyclodextrin that selectively reverses steroidal neuromuscular blocking agents (NMBAs) including rocuronium and vecuronium [1]. Sugammadex selectively encapsulates the NMBA in a one-to-one molecular interaction forming a complex and effectively removing the NMBA from the plasma. In contrast to acetylcholinesterase inhibitors, sugammadex is able to rapidly reverse even profound neuromuscular blockade occurring immediately after the administration of a NMBA. Given this rapid reversal of profound blockade, it has been suggested for use in critical situations where the rapid reversal of profound neuromuscular blockade is necessary including the "cannot intubate-cannot ventilate" (CICV) scenario [2-4]. We report the use of sugammadex to reverse neuromuscular blockade following difficulty with positive pressure ventilation after endotracheal intubation in a neonate with duodenal atresia and a tracheoesophageal fistula (TEF). The potential for its use in critical airway and ventilation scenarios is reviewed.

Case Report

Institutional Review Board approval is not required at Nationwide Children's Hospital (Columbus, Ohio) for the presentation of single case reports. The patient was a 1.77 kg, 34-week gestation neonate with duodenal atresia and tracheoesophageal fistula (TEF), presenting for emergent gastrostomy tube placement and ligation of the TEF. Following birth, multiple congenital anomalies were noted including a solitary kidney with a sacral anomaly and possible tethered cord. Apgar scores were 7 and 8 at 1 min and 5 min, respectively. A preoperative chest radiograph revealed a markedly distended stomach bubble with termination of an esophageal tube high in the upper thorax. Mild diffuse bilateral lung disease was noted suggesting either aspiration or hyaline membrane disease. On day 1 of life, she was taken to the operating room. Her vital signs were stable while breathing spontaneously on room air with a blood pressure of 48/26 mm Hg, heart rate of 137 beats/minute, and oxygen saturation (SpO_2) of 98%. Given the risks of aspiration and the potential for insufflation of the stomach through the fistula with positive pressure ventilation, the decision was made to proceed with awake endotracheal intubation followed by the induction of anesthesia. Following the administration of dexmedetomidine (1 µg/kg), the infant's trachea was intubated and positive pressure provided. As it appeared that the lungs could be effectively ventilated without insufflation of the stomach, rocuronium (1 mg/kg) and propofol (3 mg/kg) were administered. Following the administration of rocuronium, ventilation became problematic and air entry was noted into the stomach with a decrease of the SpO2 to 72%. Sugammadex (8 mg/kg) was administered and spontaneous ventilation was regained within 1 - 2 min. Anesthesia was maintained with sevoflurane with spontaneous or assisted ventilation as needed

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and the gastrostomy tube was placed. The TEF was ligated and the patient was returned with the endotracheal tube in place to the neonatal intensive care unit. The patient's trachea was extubated on postoperative day 5 and the remainder of the postoperative course was uneventful.

Discussion

For anticholinesterase inhibitors to effectively reverse competitive blockade with non-depolarizing NMBAs, the concentration of the neuromuscular blocking agent in the synaptic cleft must be relatively low and there must be significant residual neuromuscular function present. As such, in a patient such as ours, who had just received a full dose of rocuronium for endotracheal intubation, these agents would be ineffective. Three prospective trials involving a total of 180 pediatric patients have demonstrated a significantly more effective and more rapid return of the TOF to ≥ 90% with sugammadex than with neostigmine [5-7].

Given these clinical effects, sugammadex may allow the potential for the rapid pharmacologic reversal of profound neuromuscular blockade and therefore has been suggested for use in critical airway and ventilation scenarios including a CICV scenario [1]. Its potential utility in such scenarios was evaluated in a prospective trial in adults which compared the administration of rocuronium (1 mg/kg) plus sugammadex (16 mg/kg) with succinylcholine (1 mg/kg) for rapid sequence intubation [3]. The time to resumption of spontaneous ventilation was shorter in the rocuronium-sugammadex group (216 s versus 406 s). However, others have published models to simulate the duration of anesthesia, apnea, and respiratory depression using common anesthetic induction techniques with predicted rates of oxygen desaturation to explore to what degree the rapid reversal of rocuronium-induced neuromuscular blockade with sugammadex might improve the return of spontaneous ventilation in CICV situations [8]. Their simulations demonstrated that the duration of neuromuscular blockade was longer with 1.0 mg/kg succinylcholine than with 1.2 mg/kg rocuronium followed 3 min later by 16 mg/kg sugammadex (10.0 vs. 4.5 min). The authors concluded that the duration of intolerable ventilatory depression after sugammadex reversal may be as long as 15 min in 5% of individuals and therefore, the clinical management of CICV should focus primarily on restoration of airway patency, oxygenation, and ventilation consistent with the American Society of Anesthesiologist's practice guidelines for management of the difficult airway.

We report anecdotal experience with the use of sugammadex for rapid reversal of neuromuscular blockade in a patient with a TEF, in whom positive pressure ventilation became problematic after the administration of rocuronium, due to gastric insufflation through the fistula. Spontaneous ventilation resumed and oxygen saturation increased 1 - 2 min after the administration of sugammadex. To date, there is only one previous report of the use of sugammadex in a critical airway scenario [4]. The patient was a 9-month-old, 5.9 kg infant with severe stridor, scheduled for upper airway evaluation. Anesthesia was induced with a combination of propofol and fentanyl followed by the demonstration of effective bag-valve-mask ventilation and the administration of vecuronium (0.1 mg/kg). After several failed attempts at direct laryngoscopy, bag-valve-mask ventilation became difficult due to insufflation of the stomach and the oxygen saturation decreased to 75%. Sevoflurane was discontinued and sugammadex (8 mg/kg) was administrated. The time from the administration of vecuronium to the administration of sugammadex was less than 6 min. Effective spontaneous ventilation returned 25 s after the administration of sugammadex. Ninety seconds after the administration of sugammadex, the skeletal muscle tone was regained and oxygen saturation returned to 99-100% with an inspired oxygen concentration of 0.4.

This anecdotal information may be useful as recent reports and guidelines have suggested a reappraisal of specific tenets of airway management and recommend the consideration of instituting neuromuscular blockade when facing a "cannot ventilate scenario" to overcome functional airway obstruction [9, 10]. The report of the national project from the United Kingdom recommends that when CICV occurs, waking up the patient is not a first step anymore and the administration of neuromuscular blockade should occur prior to proceeding to a surgical airway. The pediatric airway guidelines from the Association of Paediatric Anaesthetists of Great Britain and Ireland (APAGBI) recommend that further attempts at endotracheal intubation should not occur without using neuromuscular blockade. They note that rocuronium is regarded as a favorable choice because of its rapid onset and the potential for reversal with sugammadex.

In summary, we present anecdotal experience with the efficacy of sugammadex to reverse neuromuscular blockade induced by rocuronium in neonate during a critical airway and ventilation scenario. When positive pressure ventilation became problematic and oxygen saturations decreased due to gastric insufflation from the TEF, spontaneous ventilation resumed and oxygen saturations increased 1 - 2 min after the administration of sugammadex. Sugammadex offers the potential for the rapid reversal of neuromuscular blockade in various critical airway and respiratory scenarios. Future anecdotal experience and prospective trials are needed to future outline its utility in these clinical scenarios.

Conflict of Interest

The authors declare that they have no competing interests.

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