Suspected Accidental Infiltration of Rocuronium During General Anesthesia Induction: A Case Report

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There are few reports on rocuronium infiltration under general anesthesia. We report a case of suspected accidental rocuronium infiltration during anesthesia induction. A 25-year-old woman with autism spectrum disorder, intellectual disability, and epilepsy was scheduled for the extraction of 4 impacted third molars under general anesthesia. After induction with sevoflurane, an intravenous (IV) line was established in the left cephalic vein. Rocuronium was administered; however, subcutaneous swelling at the IV site was observed immediately. Spontaneous ventilations were maintained until additional rocuronium was administered via a new IV line. After heat pack application, the swelling disappeared 60 minutes after infiltration, and no tissue damage was observed. A strategy was developed to continue neuromuscular monitoring until recovery occurred. Acceleromyography was used, and the train-of-4 ratios at 99, 130, and 140 minutes after infiltration were 0.79, 0.91, and 1.0, respectively. Sugammadex was administered to prevent neuromuscular blockade recurrence. The patient was extubated once adequate return of muscle function and consciousness were observed. No neuromuscular block prolongation or recurrence were observed postoperatively. When rocuronium infiltration is suspected, it is important to eliminate swelling at the infiltration site and determine a management strategy based on neuromuscular monitoring.

Key Words: Rocuronium; Infiltration; Neuromuscular monitoring.

It is important to consider the potential for localized tissue damage and altered pharmacokinetics whenever a drug intended to be administered intravenously is inadvertently administered extravascularly. Although rocuronium is routinely used during general anesthesia and in intensive care units, the pharmacokinetics of infiltrated rocuronium have not been investigated, and there are few reports on infiltrated rocuronium in the existing literature.[1–4] We report a case of suspected rocuronium infiltration during the induction of general anesthesia. The patient's mother provided written informed consent to publish the details of this report.

CASE PRESENTATION

A 25-year-old woman (height, 161.3 cm; weight, 56.1 kg; body mass index, 21.6 kg/m^2) with autism spectrum disorder, intellectual disability, and epilepsy was scheduled to undergo extraction of 4 impacted third molars under general anesthesia. Verbal communication with the patient was minimal due to her intellectual disability. She had been taking carbamazepine (4.8 g/d) orally for epilepsy for about 10 years. Her epileptic seizures were generally controlled with only 1-minute episodes of impaired consciousness occurring once every few months. She had no known food or drug allergies or history of smoking or drinking, and she had no history of general anesthesia. Preoperative blood tests, a 12-lead electrocardiogram, and chest radiography performed routinely before surgery were unremarkable.

On the morning of surgery, the patient took her daily carbamazepine 3 hours before entering operating room, but otherwise no preanesthetic medication was administered. After compliance with nothing by mouth guidelines was confirmed, the patient was monitored using an electrocardiogram, automated sphygmomanometer, pulse oximeter, and capnography. General anesthesia was induced by inhalation with sevoflurane (5%), nitrous oxide (3 L/min), and oxygen (3 L/min) via a face mask.

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Following loss of consciousness, the patient's airway was easily kept patient during spontaneous ventilation using a tight seal with the facemask and a slight jaw thrust. An intravenous (IV) line was then established in the left cephalic vein with a 22-G IV catheter. After confirming retrograde blood flow and initiating administration of IV fluids with Ringer acetate solution, an IV bolus of rocuronium (35 mg; 0.62 mg/kg) was administered without any notable excessive backpressure.

However, an oval-shaped swelling approximately 4 × 6 cm in diameter was discovered at the tip of the IV catheter immediately after rocuronium administration. Redness was not observed in the edematous area. The patient continued to breathe spontaneously at this time. The swelling was considered to be caused by an infiltrated IV line, and the IV catheter was immediately removed. While assisted mask ventilation was easily performed, a new IV line was rapidly established in the right cephalic vein with a 22-G IV catheter. At this point, an additional bolus of rocuronium (15 mg; 0.27 mg/kg) and 100 μg of fentanyl were administered, and a continuous infusion of remifentanil was started at 0.18 μg/kg/min.

The patient maintained spontaneous ventilations approximately 5 minutes after the first rocuronium bolus was administered. Tracheal intubation was attempted 14 minutes after the infiltration was confirmed and 6 minutes after the additional bolus of rocuronium was administered. At that time, there was no spontaneous ventilation or body movement. Direct laryngoscopy using a Macintosh 3 blade revealed a Cormack-Lehane grade 1 view and an open glottis. The patient was intubated using a cuffed nasal endotracheal tube (size 6.5), and bilateral lung expansion, bilateral breath sounds, and a normal capnogram provided confirmation of the successful intubation.

General anesthesia was maintained with sevoflurane (1.3%), oxygen (1 L/min), air (2 L/min), and a continuous infusion of remifentanil at 0.09 to 0.18 μg/kg/min. No additional rocuronium was administered intraoperatively. The swelling in the patient's left forearm was warmed with a heat pack, and it disappeared approximately 60 minutes after discovery.

Acceleromyography using a TOF-Watch (MSD K.K.) was performed after induction. The train-of-4 (TOF) ratio increased over time and was 0.79 by the end of surgery, approximately 99 minutes after the suspected infiltration was noted. After conclusion of the surgery, 0.8% sevoflurane continued to be administered while the TOF was observed. Approximately 115 minutes after the suspected infiltration, spontaneous ventilations resumed and continued regularly with a tidal volume of approximately 450 mL and a respiratory rate of approximately 10 breaths/min. Roughly 140 minutes after the suspected infiltration, the TOF ratio was 1.0. Sevoflurane was discontinued at that time, and sugammadex (200 mg) was administered. The patient regained consciousness approximately 7 minutes later and was extubated without difficulty in the operating room. The patient's respiratory status remained stable thereafter. The operation time was 58 minutes, and the total anesthesia time was 2 hours and 38 minutes.

Pulse oximeter monitoring was continued for 6 hours after moving the patient to the general ward, and no decrease in arterial oxygen saturation was observed. She was able to drink water and walk without problems approximately 2 hours after the end of anesthesia. There was no recurrence of neuromuscular blockade, and the patient was discharged home the following day.

DISCUSSION

Infiltration Causes, Prevention, Confirmation Methods, and Countermeasures

Considering the routine nature of how anesthesiologists administer IV drugs, understanding the potential consequences of infiltrated drugs is critical. Common causes of IV infiltration are inadvertent extravascular catheter placement, catheter dislodgement due to inadequate immobilization or repositioning, and leakage from the vessel puncture site. To prevent infiltration, it is necessary to (1) ensure appropriate catheter length within the vessel, (2) avoid placing IV catheters in highly mobile areas, (3) master reliable IV cannulation techniques, and (4) avoid high-pressure and large-volume IV injections.

It is particularly important to detect extravascular catheter placement prior to administering any drugs. The following methods can be used to confirm whether the IV catheter is properly placed within the vessel: observation of free-flowing IV fluids, retrograde flow or positive aspiration of blood through the IV catheter, lack of significant backpressure when injecting fluids or medications, and flow visualization of administered fluids or medications by color Doppler.[5] Should IV infiltration be suspected, initial measures include immediately discontinuing the administration of any IV fluids or medications and establishing a new IV line as necessary. Possible secondary measures that should be done as soon as possible include the following: aspirating infiltrated fluid from the cannula, removing the cannula, elevating the affected limb, and applying heat therapy or cold compression.[6,7]

Rocuronium Onset Time and the Impact of Infiltration

The onset time for IV rocuronium (0.6 mg/kg) from administration until TOF count = 0 was reported to range from 60 to 105 seconds.[8] The onset time of infiltrated rocuronium is reportedly prolonged compared with IV administration. In the present case, a subcutaneous swelling appeared immediately after the first dose of rocuronium, and the patient continued spontaneously ventilating while a new IV line was established, which took approximately 5 minutes, despite the administration of 0.6 mg/kg rocuronium. Detailed TOF values could not be measured because of a delay in neuromuscular monitoring due to prioritizing the new IV; however, the onset time for paralysis (ie, loss of spontaneous ventilation and body movement) was clearly longer than the expected onset time of intravenously administered rocuronium. Therefore, we felt it likely the subcutaneous swelling contained a significant amount of the initial rocuronium bolus.

Prolongation of Paralysis Due to Infiltration

In contrast to the onset time, the duration of action of infiltrated rocuronium varies between reports.[1–4] The following are the reasons for the differences in each case: the rocuronium dose administered and degree of infiltration; the rate of absorption locally into blood vessels and lymphatic vessels; the effects of comorbid diseases on peripheral circulation, metabolism, and excretion; and interactions with concurrently administered drugs.

Lee et al[9] reported that the mean duration of action (TOF ratio 0.9) of IV rocuronium at 0.3, 0.6, and 0.9 mg/kg under sevoflurane was 66.5 ± 39.3 minutes, 110.2 ± 43.5 minutes, and 144 ± 57.5 minutes, respectively.[9] However, the duration of action in our case was not markedly prolonged compared with the study described above given the doses administered (IV bolus before detecting the infiltration: 0.62 mg/kg; IV bolus after detection: 0.27 mg/kg). This may be attributed to the heat pack that was applied to the infiltration site, which could have promoted rocuronium absorption into the blood and prevented prolonged neuromuscular blockade. Additionally, the patient was also taking daily carbamazepine, which can cause a drug interaction that shortens the duration of action of neuromuscular blockade.[10]

Countermeasures Assuming Rocuronium Infiltration in this Case

We administered 15 mg of additional rocuronium, which is roughly equal to 0.3 mg/kg 95% effective dose for safe and smooth tracheal intubation. However, in retrospect, it would have been more ideal to check the degree of paralysis with neuromuscular monitoring before administering additional rocuronium. Muscle relaxation was not essential during this surgery, and intubation without neuromuscular blocking agents or the use of a supraglottic device could have been considered. Additional doses of neuromuscular blocking agents should be considered and titrated to effect based on the results of neuromuscular monitoring and according to the difficulty of securing the airway and type of surgery.

When the subcutaneous infiltration depot remained clearly visible, the possibility of prolonged neuromuscular blockade or recurrence could not be ruled out. Therefore, it was important to take measures to promote drug absorption at the infiltration site. Application of heat to the infiltration site may have partly contributed to the absence of a delayed muscle relaxation effect in this case, as mentioned above.

It is also important to plan a postoperative management strategy based on trends in TOF ratios over an extended timeframe. If it is not possible to secure an intensive care unit or a bed with ventilatory management for immediate response to recurrent or prolonged neuromuscular blockade, waiting for ideal recovery from muscle relaxation while continuing to administer anesthetics in the operating room may be another option. In our case, we kept the sevoflurane on until we observed a TOF ratio of 1.0 to prevent the patient from awakening while still under the effects from the rocuronium.

Additionally, sugammadex can help prevent the recurrence of neuromuscular blockade.[2] Unlike neostigmine, sugammadex directly counters the action of rocuronium and vecuronium in the blood plasma by effective encapsulation. Sugammadex has been reported to be a more useful neuromuscular reversal drug in cases of rocuronium infiltration because it encapsulates rocuronium, which might be absorbed gradually from the infiltration area into the systemic circulation. Our patient was extubated after sugammadex was administered for the above effect.

Tissue Damage Due to Infiltration

IV infiltration can cause localized tissue damage depending on the specific drug. The mechanisms related to tissue damage depend on the drug's pH, high osmolarity, vasoconstriction, cytotoxicity, and poor absorbability.[7] There is a report[11] of tissue damage caused by infiltrated propofol, which is said to be relatively safe after IV infiltration because the pH and osmotic pressure ratio are 7.0 to 8.5 and approximately

1.0, respectively. However, the pH and osmotic pressure ratio of the rocuronium potentially infiltrated in this case were 2.8 to 3.2 and approximately 1.0, respectively. There have been no reports of tissue damage in cases of rocuronium infiltration, and no tissue damage was observed in this case. Therefore, it appears that rocuronium does not cause tissue damage. There are few reports on rocuronium infiltration; however, further research is required to determine whether rocuronium causes tissue damage.

CONCLUSION

We encountered a case in which infiltration of rocuronium was suspected during anesthesia induction. In case of infiltrated rocuronium, it is important to immediately cease use of the infiltrated IV and quickly establish new IV access. After those steps, try to eliminate the swelling at the infiltration site and develop a management strategy that should include the use of TOF monitoring, continued observation until muscle function is restored, and the administration of sugammadex.

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