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Effectiveness of Rocuronium bromide: An assessment

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Abstract

The study focuses on succinylcholine, a commonly used muscle relaxant for pediatric patients, and rocuronium, a newer non-depolarizing muscle relaxant. The objective was to evaluate the onset time, progression, and duration of muscle relaxation, as well as tracheal intubation conditions for both drugs. This randomized, double-blind study was conducted on 50 pediatric patients aged 2 to 6 years, classified as ASA grade I and II, who underwent surgeries lasting less than 30 minutes. Patients received either intravenous rocuronium (0.9 mg/kg) or succinylcholine (1.5 mg/kg) following premedication with fentanyl (1 µg/kg) and thiopentone (5 mg/kg). Neuromuscular blockade was assessed by measuring the twitch response of the adductor pollicis longus muscle after supra-maximal stimulation of the ulnar nerve. An independent, blinded anesthetist evaluated the tracheal intubation conditions one minute after drug administration and then every 15 seconds until successful intubation. The onset time and degree of neuromuscular blockade were also recorded during the procedure.

Keywords: Neuromuscular Relaxant, Pediatric Patients, Succinylcholine, Rocuronium, TOF Guard, Intraoperative Pressure.

INTRODUCTION

This study was a randomized, blind trial conducted to evaluate tracheal intubation conditions using two different muscle relaxants in 50 pediatric patients aged 2 to 6 years, classified as ASA grade I and II, who underwent surgeries lasting less than 30 minutes. Patients were anesthetized with either intravenous rocuronium (0.9 mg/kg) or succinylcholine (1.5 mg/kg) following the administration of fentanyl (1 µg/kg) and thiopentone (5 mg/kg). Neuromuscular blockade was assessed by monitoring the twitch response of the adductor pollicis longus muscle after supra-maximal stimulation of the ulnar nerve. A blinded anesthetist evaluated tracheal intubation conditions 60 seconds after drug administration and subsequently every 15 seconds until successful intubation was achieved. Additionally, the onset time and the percentage of neuromuscular blockade were measured. The rocuronium group exhibited a

longer onset time and duration of action compared to the succinylcholine group. Succinylcholine is a depolarizing muscle relaxant commonly used for rapid endotracheal intubation and has been in clinical practice for several decades. However, it is associated with various complications, including increased intraocular pressure (IOP), malignant hyperthermia, asystole, and bradycardia. Due to the risk of hyperkalemic cardiac arrest in children with undiagnosed muscular dystrophy, there have been increasing efforts to limit its use in pediatric patients (Badgwell, Hall, & Lockhan, 1994; Goudsouzaian, 1995; Bevan, 1994; Hopkins, 1995). It is also suggested that if an alternative drug offers similar efficacy with fewer side effects, it may be preferable to avoid the use of succinylcholine.

Rocuronium is a steroidal, non-depolarizing neuromuscular blocking agent characterized by a rapid onset, intermediate duration of action, and stable hemodynamic profile. Its neuromuscular potency is approximately one-fifth that of vecuronium.

This study aimed to evaluate tracheal intubation conditions in a blinded manner after administering rocuronium at a dose of 3 *ED95 (0.9 mg/kg) and to compare its effects with succinylcholine (1.5 mg/kg).

The study included pediatric patients classified as ASA grade I and II, focusing on the onset of action and intubation conditions with rocuronium to determine its suitability as an alternative when succinylcholine is relatively contraindicated. Neuromuscular blockade was primarily assessed using the TOF (Train-of-Four) guard as the key measurement parameter.

METHODS

Ethics committee approval was obtained before initiating the study, and informed consent was taken from the parents of all participants. The study involved ASA grade I and II pediatric patients aged between 2 and 6 years, with a total of 50 patients included. Patients with neuromuscular disorders, airway abnormalities, or those receiving medications affecting neuromuscular transmission were excluded from the study.

Intravenous lines were secured, and all patients received premedication with atropine (0.01 mg/kg) and fentanyl (1 µg/kg). Following premedication, pulse oximetry and noninvasive blood pressure (BP) monitoring were initiated, and a thorough evaluation of vital organs was performed. Electrodes from the TOF (Train-of-Four) nerve stimulator were positioned on the forearm to stimulate the ulnar nerve. The active electrode was placed on the palm at the apex of the interphalangeal space between the thumb and index finger, while the reference electrode was positioned on the palmar surface at the base of the index finger. The test hand was immobilized in a supine position using an armboard, allowing free movement during evoked thumb adduction by securing the extended ulnar fingers with adhesive tape.

Patients were preoxygenated using 100% oxygen. Anesthesia was induced with thiopentone sodium (5 mg/kg) and either rocuronium (0.9 mg/kg) or succinylcholine (1.5 mg/kg). Before administering any muscle relaxant, the supramaximal stimulus was determined using the TOF (Train-of-Four) guard by observing contractions of the adductor pollicis and flexor digitorum muscles. Thumb adduction was measured through a force displacement transducer, and the time of relaxant injection was recorded. Single twitch stimulation was applied every second until complete suppression (100%) of the control twitch response was achieved. Intubating conditions were evaluated by the same blinded anesthetist using the Goldberg scale. Anesthesia was maintained with a mixture of 40% oxygen, 60% nitrous oxide, and intermittent sevoflurane (0.5% to 0.8%). After surgery, in the rocuronium group, neuromuscular blockade was reversed using intravenous atropine (0.02 mg/kg) and neostigmine (0.05 mg/kg). The statistical significance between the two groups was analyzed using the Chi-square test, with a significance level set at $p < 0.05$.

Throughout the operation, heart rate and noninvasive blood pressure were monitored using a Cardiocap monitor at one-minute intervals for the first 30 minutes, followed by three-minute intervals thereafter. Oxygen saturation and end-tidal carbon dioxide ($ETCO_2$) were

continuously monitored during the procedure. Normocapnia and normal body temperature were maintained throughout the surgery.

RESULTS

Results are as follows.

Table 1

Demographic Characteristics

	R (n=25)	S (n=25)	P value
Age (Years)	3.13 +/- 0.99	3.71+/- 1.10	>0.05
Weight (Kg)	12.10 +/- 1.32	10.79 +/- 1.99	>0.05
Sex (M/F)	13/12	14/11	>0.05

The Tukey test was used to evaluate significant statistical differences between the two groups. The results indicated no significant differences between the groups concerning age, weight, and gender.

Table 2

Time, Course and Action (in Minutes)

	R (n=25)	S (n=25)	P value
Onset time	91 +/- 36.44	71.43+/- 11.23	<0.001
Clinical duration	29 +/- 7	9 +/- 4	<0.001

In the rocuronium group, complete suppression (100%) of the supramaximal stimulus was observed in 18 patients, while 95% suppression was noted in 7 patients. In the succinylcholine group, 100% suppression was achieved in 20 patients, and 94% suppression was observed in 5 patients. Following the administration of rocuronium, 5 patients were intubated within 90 seconds, while 20 patients were successfully intubated within 60 seconds. In contrast, all 25 patients in the succinylcholine group were intubated within 60 seconds. The onset time was significantly shorter with succinylcholine (71.43 ± 11.23 seconds) compared to rocuronium (91 ± 36.44 seconds), with a *p*-value of <0.001, indicating a statistically significant difference.

Table 3

Scoring of Intubating Conditions

Score	**Jaw Relaxation**	**Vocal Cords**	**Response to itubation**
0	Poor	Closed	Severe Coughing
1	Minimal	Closing	Mild Cough
2	Moderate	Moving	Slight diaphragmatic movement
3	Good	Opened	None

A total score of 8-9 was classified as excellent, 6-7 as good, 3-5 as fair, and 0-2 as poor. In both the rocuronium and succinylcholine groups, a total score of 8-9 was observed, with no significant difference between the groups ($p > 0.05$).

Discussion

The objective of this study was to compare intubation conditions using either 0.9 mg/kg of rocuronium or 1.5 mg/kg of succinylcholine to determine whether rocuronium could provide suitable intubation conditions and serve as a viable alternative when succinylcholine is contraindicated. The Malignant Hyperthermia Associations of the United States and Germany strongly recommend discontinuing the use of succinylcholine due to its severe side effects,

including acidosis, rhabdomyolysis, hyperkalemia, and cardiac arrest (Fuchs, Buder, & Tassonyi, 1996; Curl, & Vanbellegham, 1995).

A study conducted by O'Kelly B. et al. (Okelly, & Frosad, 1991) on the pharmacokinetics of rocuronium in pediatric patients concluded that body weight is a more accurate basis for dose calculation than body surface area. Based on these findings, we selected a bolus dose of 0.9 mg/kg of rocuronium (3*ED95). The quality of neuromuscular blockade at the larynx was assessed using intubation scores, which demonstrated comparable results.

Rocuronium blocks laryngeal muscles earlier than the adductor pollicis, and the ease of intubation cannot be fully assessed using single twitch depression. In the rocuronium group, all patients displayed excellent or good intubation conditions when there was no diaphragmatic activity. These findings suggest that rocuronium is a useful alternative when succinylcholine is relatively contraindicated.

Curl and colleagues (Curl, & Vanbellegham, 1995) reported favorable intubating conditions with rocuronium at 45 seconds using a dose of 0.6 mg/kg in combination with propofol and fentanyl (2 µg/kg). In our study, fentanyl was used as the analgesic agent.

Fentanyl is a short-acting opioid with hypnotic properties. Curl and associates also administered propofol, which relaxes the laryngeal muscles, enabling intubation within 45 seconds, whereas in our study, intubation was achieved within 60 seconds. According to Fuchs, Budder, and Tassonyi (Fuchs, Buder, & Tassonyi, 1996), increasing the rocuronium dose from 0.6 mg/kg to 0.9 mg/kg in pediatric patients significantly shortened the onset time while prolonging the duration of action.

Susan Woelfel (Woelfel, Brandom, & Cook, 1992) reported a clinical duration of 26.7 ± 1.9 minutes with a 0.6 mg/kg dose, while Stoddart observed a duration of 24.2 ± 6.6 minutes. In our study, the duration of action was approximately 28 minutes with a 0.9 mg/kg dose of rocuronium. The extended duration may be attributed to the higher rocuronium dose and the combined effect of rocuronium and fentanyl.

Given the longer onset time with rocuronium, our findings are noteworthy, particularly considering that succinylcholine was administered at a dose of 4.5*ED95, while rocuronium was given at 2*ED95.

Our results support the hypothesis that the onset of motor blockade in the vocal cords and diaphragm following rocuronium administration does not significantly differ from that of succinylcholine.

FINAL THOUGHTS

The pre-induction administration of opioids significantly improved intubation conditions with rocuronium. In conclusion, our study suggests that rocuronium at a dose of 3*ED95 (0.9 mg/kg) can serve as a viable alternative to succinylcholine in pediatric patients where succinylcholine is contraindicated.

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