CLINICAL STUDY

Minimal Intubating Dose of Succinylcholine: A Comparative Study of 0.4, 0.5 and 0.6 mg/kg Dose

AJIT GUPTA*, SAURAV SHEKHAR*, ANKESH*, RAJESH KUMAR, JAY PRAKASH

ABSTRACT

Muscle relaxants are integral part of modern balanced anesthesia and succinylcholine, a depolarizing drug, is in use despite its adverse effects. The excellent intubating condition, fastest onset and shortest duration of action make it an excellent choice for anesthesiologists. The conventional dose of 1.5-2 mg/kg is commonly used for obtaining relaxation for intubation. This study was conducted with much smaller dose of succinylcholine as 0.4, 0.5 and 0.6 mg/kg to evaluate the acceptable intubating dose at 60 seconds, which was unlikely to have any untoward/side effects.

Keywords: Succinylcholine, low dose, intubation

Muscle relaxants are integral part of balanced anesthesia since first dose of curare in 1942. For last-half century, succinylcholine continues to be used as relaxant for rapid intubation due to its unparallel efficacy, rapid onset with short duration of action thus providing excellent intubating conditions. Succinylcholine is considered the best drug in the hands of anesthesiologists in emergency condition for rapid sequence intubation due to its rapid onset.

In conventional dose of 1.5-2 mg/kg, various side effects of succinylcholine can become evident. Various adverse events such as cardiac arrhythmias, exaggerated potassium reflux, increased intraocular and intracranial pressure, masseter spasm, myalgia due to muscle fasciculations can occur susceptible population at usual conventional doses.

Rocuronium has recently gained popularity as relaxant for fast intubating conditions but has longer duration of action, which is undesirable in various situations. In spite of all claims by newer muscle relaxants, benefits of succinylcholine cannot be overlooked. Knowing the potential side effects of succinylcholine at conventional doses, minimal dose should be used to avoid possible complications.

*Dept. of Anesthesiology
Indira Gandhi Institute of Medical Sciences, Patna, Bihar, India
Address for correspondence
Dr Ajit Gupta
Professor and Head
Dept. of Anesthesiology
Indira Gandhi Institute of Medical Sciences, Patna - 800 014, Bihar, India
E-mail: ajpta_igims@yahoo.co.uk

AIMS OF STUDY

This study was aimed to assess three minimal doses of succinylcholine for muscle relaxation for intubation. In present study, we compared succinylcholine in three minimal doses of 0.4, 0.5 and 0.6 mg/kg for its efficacy in providing satisfactory intubating condition.

Inclusion Criteria

- Age 15 to 65 years of either sex posted for elective surgery.
- American Society of Anesthesiologist (ASA) Grade I and II.

Exclusion Criteria

- Patient refusal.
- Posted for any emergency surgery.
- Patients with coexisting diseases such as any cardiac, renal, diabetes, hypertension, electrolyte imbalance, etc.
- Any history of allergic reaction to any drugs involved.
- Anticipated difficult airway.

MATERIAL AND METHODS

After institutional ethical clearance, total of 120 patients (40 in each group) were included in this prospective,

randomized double-blind study after applying inclusion and exclusion criteria.

- Group A: 0.4 mg/kg diluted into total of 2 mL volume with normal saline.
- Group B: 0.5 mg/kg diluted into total of 2 mL volume with normal saline.
- Group C: 0.6 mg/kg diluted into total of 2 mL volume with normal saline.

Methodology

After obtaining prior written informed consent, detailed pre-anesthetic check-up were done for all patients included in the study. Patients were shifted to operation theater after overnight fasting of 6 hours and standard monitors (NIBP, SpO_2, ECG, capnography) were attached.

All patients were pre-medicated with injection glycopyrrolate 0.2 mg and injection fentanyl 2 mg/kg intravenously (IV) and pre-oxygenated with 100% oxygen for 3 minutes. Patients were induced with injection propofol 2 mg/kg IV. After loss of eyelash reflex, set dose of succinylcholine was administered to the patient by a helping colleague not involved in the study. After 1 minute (60 seconds), laryngosopy to assess intubating condition was done by the investigator and patient was intubated.

Maintenance of anesthesia was done with oxygen, nitrous oxide (50:50), isoflurane, vecuronium and intermittent positive pressure ventilation (IPPV). Patients were reversed with injection neostigmine 0.05 mg/kg and injection glycopyrrolate 0.01 mg/kg at the end of surgery and extubated after thorough oral suctioning.

Clinically, intubating conditions were observed as described by Cooper et al as in the following:

Score	Jaw relaxation	Vocal cord	Response to intubation
0	Poor (impossible)	Closed	Severe coughing/ bucking
1	Minimal	Closing	Mild cough
2	Good (easy)	Minimal movement	Mild diaphragmatic movement
3	Excellent	Open	None

Total score: 8-9: Excellent; 6-7: Good; 3-5: Fair; 0-3: Poor.

If difficult/poor intubating conditions were encountered, then additional dose of injection propofol 0.5 mg/kg was given and return of spontaneous ventilation was awaited. Injection vecuron 0.1 mg/kg was then given and patient was then intubated after 3 minutes. Such patients automatically had score of 0 or poor intubating condition. In no circumstances, second dose of succinylcholine was given.

Vitals Monitoring and Statistical Analysis

Vitals (heart rate, systolic blood pressure, diastolic blood pressure) were noted at pre-induction state and then at 0, 1, 2, 3, 5 and 10 minutes post-intubation. All data were compared statistically using Epi Info 3.3.2 database and analysis of variance (ANOVA) analysis was used for inter-group comparison. P value <0.05 was considered significant and p value <0.001 was highly significant.

RESULTS

We were able to intubate all patients with different observations. On analysis of demographic profile, maximum proportion (46.6%) was from age group 15 to 25 and 35 to 45 years. All the three study groups were comparable with demographic profile and were found to be statistically insignificant (Tables 1-3). In our study, we found that intubating condition was dosedependent at fixed time interval of 60 seconds. Eighty percent of patients with 0.4 mg/kg, 95% with 0.5 mg/kg and 100% patients with 0.6 mg/kg had excellent to fair intubating condition (Table 4).

Our study revealed that all patients with 0.6 mg/kg succinylcholine, had excellent intubating condition

Table 1. Group-wise Age Distribution

Age (years)	Group A	Group B	Group C	Total
15-25	8 (20%)	9 (22.5%)	11 (27.5%)	28 (23.3%)
25-35	7 (17.5%)	8 (20%)	6 (15%)	21 (17.5%)
35-45	10 (25%)	8 (20%)	10 (25%)	28 (23.3%)
45-55	3 (7.5%)	8 (20%)	9 (22.5%)	20 (16.7%)
55-65	12 (30%)	7 (17.5%)	4 (10%)	23 (19.2%)
Total	**40 (100%)**	**40 (100%)**	**40 (100%)**	**120 (100%)**

Table 2. Group-wise Sex Distribution

Sex	Group A	Group B	Group C	Total
Male	22 (55%)	24 (60%)	23 (57.5%)	69 (57.5%)
Female	18 (45%)	16 (40%)	17 (42.5%)	51 (42.5%)
Total	**40 (100%)**	**40 (100%)**	**40 (100%)**	**40 (100%)**

Table 3. Group-wise Weight Distribution

Weight (kg)	Group A	Group B	Group C	Total
30-40	3 (7.5%)	4 (10%)	4 (10%)	11 (9.2%)
40-50	8 (20%)	11 (27.5%)	10 (25%)	29 (24.2%)
50-60	8 (20%)	11 (27.5%)	10 (25%)	29 (24.2%)
60-70	15 (20%)	14 (35%)	16 (40%)	45 (37.5%)
70-80	6 (15%)	3 (7.5%)	1 (2.5%)	10 (8.3%)
Total	**40 (100%)**	**40 (100%)**	**40 (100%)**	**120 (100%)**

Table 4. Clinical Intubating Condition in Different Groups

	Group A	Group B	Group C
Jaw relaxation			
Poor	1 (2.5%)	Nil	Nil
Minimal	7 (17.5%)	2 (5%)	Nil
Good	11 (27.5%)	12 (30%)	8 (20%)
Excellent	21 (52.5%)	26 (65%)	32 (80%)
Vocal cord movement			
Closed	Nil	Nil	Nil
Closing	6 (15%)	1 (2.5%)	Nil
Minimal movement	12 (30%)	14 (35%)	6 (15%)
Open	22 (55%)	25 (62.5%)	34 (85%)
Response to intubation			
Severe coughing/bucking	2 (5%)	1 (2.5%)	Nil
Mild cough	6 (15%)	1 (2.5%)	Nil
Mild diaphragmatic movement	13 (32.5%)	12 (30%)	2 (5%)
None	19 (47.5%)	26 (65%)	38 (95%)

with onset of action as fast as 1.0 mg/kg dose. Thus in our view, dose higher than 0.6 mg/kg has no added advantage and unnecessarily produces side effects. There was maximum proportion (90%) showing excellent intubating condition in Group C as compared to Groups A and B. On the other side, good condition was found maximum (55%) in Group B compared to Group A and C. Fair and poor condition was found maximum in Group A (55% and 20%, respectively) (Table 5).

It was observed that 20% patients in 0.4 mg/kg group and 5% patients in 0.5 mg/kg group had poor intubating condition with some movement of vocal cords. However, post-extubation none of the endotracheal (ED) tube showed any blood on its tip. In our study, we did not use neuromuscular monitoring and solely depended on clinical judgment, hence exact onset and recovery

Table 5. Distribution of Intubating Condition among Study Groups

Condition	Group A	Group B	Group C	Total
Excellent	0 (0)	12 (30%)	36 (90%)	48 (40%)
Good	10 (25%)	22 (55%)	2 (5%)	34 (28.4%)
Fair	22 (55%)	4 (10%)	2 (5%)	28 (23.3%)
Poor	8 (20%)	2 (5%)	0 (0%)	10 (8.3%)
Total	**40 (100%)**	**40 (100%)**	**40 (100%)**	**120 (100%)**

time could not be assessed. We solely concentrated on minimal intubating dose and associated intubating condition.

DISCUSSION

The usual intubating dose for succinylcholine is 1.0-1.5 mg/kg IV to achieve satisfactory intubating condition at 1 minute. This dose is associated with various adverse effects[1] and has drawbacks, which attracted too many adverse comments. Succinylcholine still enjoys patronage of many anesthesiologists because it provides excellent intubating conditions and has shorter onset of action. The efficacy of small dose of succinylcholine for providing acceptable intubating conditions at 60 seconds was reported by Stewart et al[2] in their study titled "Comparison of high and low doses of succinylcholine". Later Nimmo et al[3] reported "Effectiveness and sequelae of very low-dose of succinylcholine". These studies did not get attention because of fear that respiration will return faster and intubation will be difficult.

Stewart et al[2] reported that 26 (96%) of 27 patients receiving 1.5 mg/kg succinylcholine and 30 (94%) of 32 patients receiving 0.5 mg/kg had acceptable intubating conditions. However, in patients with a full stomach or in those with raised intracranial pressure, excellent intubating conditions are warranted.

ED 95 of succinylcholine is 0.3 mg/kg and traditional dose of 1.0-1.5 mg/kg is too high (3 × ED) and produces side effects, which has been well proven in study conducted by Smith et al.[4] Same has been proposed by Kopman[5] study. Naguib et al[6] compared 0.3, 0.4, 0.5, 1.0 and 2.0 mg/kg dose of succinylcholine and found no difference of intubating condition at 60 seconds with doses of 1.0 and 2.0 mg/kg. Naguib et al[7,8] also found the incidence of excellent intubating conditions following induction with 2 μg/kg fentanyl and 2 mg/kg propofol to be 43.3%, 60.0%, 63.3%, 80.0% and 86.7% of patients after 0.3, 0.5, 1.0, 1.5 and 2.0 mg/kg

succinylcholine, respectively. El-Orbany et al[9] in their study found that small doses of succinylcholine like 0.5, 0.6 and 0.8 mg/kg are sufficient for good intubating conditions at 60 seconds.

Benumof et al[10] observed that recovery occurred much earlier with 0.5 mg/kg than with 1.0 mg/kg dose of succinylcholine and this created additional benefits. Another study by Ellango et al[11] opined that intubating condition was much better with 1.0 mg/kg compared to 0.5 mg/kg but desaturation was more with 1.0 mg/kg dose. Ezzat and colleagues[12] studied the optimal succinylcholine dose for intubating emergency patients in a retrospective comparative study. They studied succinylcholine as a muscle relaxant agent in doses of 0.45 mg/kg, 0.6 mg/kg or 1 mg/kg and found that increasing the succinylcholine dosage shortened the onset time, prolonged the duration of action and the duration of abdominal fasciculation significantly. Tracheal intubation was 100% successful in the three groups of patients.

Sorensen et al[13] studied rapid sequence induction and intubation with rocuronium-sugammadex compared with succinylcholine in a randomized trial. They used either succinylcholine (1 mg/kg^{-1}) or rocuronium (1 mg/kg^{-1}) and found that median time from tracheal intubation to spontaneous ventilation was 406 seconds with succinylcholine and 216 seconds with rocuroniumsugammadex. The median time from tracheal intubation to 90% recovery of the first twitch in train-of-four (T_1 90%) was 518 seconds with succinylcholine and 168 seconds with rocuronium-sugammadex and intubating conditions and time to tracheal intubation were not significantly different.

Few studies have shown desaturation of oxyhemoglobin during apneic period. Though we did not include it in our protocol, none of the patients enrolled in our study showed any sign of desaturation as all were preoxygenated for 3 minutes and intubated at 60 seconds.

CONCLUSION

Succinylcholine due to its rapidity of onset and offset with excellent effect still enjoys patronage of many anesthesiologists. By using low dose of succinylcholine many side effects can be avoided and can be safely used in patients.

REFERENCES

1. Savarese JJ, Caldwell JE, Lien CA, Miller RD. Pharmacology of muscle relaxants and their antagonists. In: Miller RD (Ed.). Anesthesia. 3rd Edition, New York: Churchill Livingstone; 2000. pp. 412-90.
2. Stewart KG, Hopkins PM, Dean SG. Comparison of high and low doses of suxamethonium. Anaesthesia. 1991;46(10):833-6.
3. Nimmo SM, McCann N, Broome IJ, Robb HM. Effectiveness and sequelae of very low-dose suxamethonium for nasal intubation. Br J Anaesth. 1995;74(1):31-4.
4. Smith CE, Donati F, Bevan DR. Dose-response curves for succinylcholine: single versus cumulative techniques. Anesthesiology. 1988;69(3):338-42.
5. Kopman AF, Klewicka MM, Neuman GG. An alternate method for estimating the dose-response relationships of neuromuscular blocking drugs. Anesth Analg. 2000;90(5):1191-7.
6. Naguib M, Samarkandi A, Riad W, Alharby SW. Optimal dose of succinylcholine revisited. Anesthesiology. 2003;99(5):1045-9.
7. Naguib M, Samarkandi AH, El-Din ME, Abdullah K, Khaled M, Alharby SW. The dose of succinylcholine required for excellent endotracheal intubating conditions. Anesth Analg. 2006;102(1):151-5.
8. Naguib M, Samarkandi AH, Abdullah K, Riad W, Alharby SW. Succinylcholine dosage and apnea-induced hemoglobin desaturation in patients. Anesthesiology. 2005;102(1):35-40.
9. El-Orbany MI, Joseph NJ, Salem MR, Klowden AJ. The neuromuscular effects and tracheal intubation conditions after small doses of succinylcholine. Anesth Analg. 2004;98(6):1680-5.
10. Benumof JL, Dagg R, Benumof R. Critical hemoglobin desaturation will occur before return to an unparalyzed state following 1 mg/kg intravenous succinylcholine. Anesthesiology. 1997;87(4):979-82.
11. Ellango AP, Krishna HM, Gurudas K. Comparative evaluation of low dose succinylcholine against standard intubating dose in children. J Anesth Clin Pharmacol. 2009;25(4):413-6.
12. Ezzat A, Fathi E, Zarour A, Singh R, Abusaeda MO, Hussien MM. The optimal succinylcholine dose for intubating emergency patients: retrospective comparative study. Libyan J Med. 2011;6:10.
13. Sørensen MK, Bretlau C, Gätke MR, Sørensen AM, Rasmussen LS. Rapid sequence induction and intubation with rocuronium-sugammadex compared with succinylcholine: a randomized trial. Br J Anaesth. 2012;108(4):682-9.