



Rocuronium versus Succinylcholine for Rapid Sequence Intubation

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Abstract

Background: Patients often require a rapid sequence intubation technique during emergencies or electively to protect against aspiration, raised intracranial pressure (ICP) or to facilitate intubation. Rapid sequence intubation involves the administration of a hypnotic and paralytic agent that has rapid onset of action.¹ The neuromuscular agent improves the overall conditions of intubation and success rate of first attempt intubation. The present study was designed to compare Rocuronium versus succinylcholine for rapid sequence intubation,

Materials and Methods: In this comparative, prospective and observational study total 60 patients were enrolled undergoing rapid sequence intubation and divided into 2 groups. Group A received Injection Rocuronium bromide in a dose of 0.9 mg/kg, Group B received Injection Succinylcholine chloride in a dose of 2 mg/kg. Both the groups were observed to evaluate the intubating conditions at 60 seconds, compare the haemodynamic response to intubation, complications related to procedure and drugs.

Results:- Laryngoscopy and endotracheal intubation in each group were assessed and graded as per Cooper et al criteria. In both group A and B all (100%) patients had clinically acceptable intubating conditions. Rocuronium also provides rapid onset of action and better clinically acceptable intubating conditions at 60 seconds after bolus dose of 0.9 mg/kg when compared with Succinylcholine at the dose of 2 mg/kg. There was no statistically significant difference in haemodynamic parameters like heart rate, systolic blood pressure, diastolic blood pressure and mean arterial pressure among both groups. ($p > 0.05$) All patients in each group had normal SpO₂ throughout the study. No complications related to procedure like airway injuries associated with laryngoscopy and no complications related to drugs were observed in any group.

Conclusion: From the results of our study it can be concluded that though Succinylcholine is the muscle relaxant of choice for rapid sequence intubation, but in new era nondepolarizing neuromuscular blocking agent Rocuronium 0.9 mg/kg can also provide excellent intubating condition as well as stable haemodynamics as compared to Succinylcholine 2 mg/kg for rapid sequence endotracheal intubation at 60 seconds and can be used as alternative to Succinylcholine 2 mg/kg in cases where Succinylcholine is contraindicated.

Key words: Rocuronium, Succinylcholine, Rapid sequence intubation Hemodynamic stability.

INTRODUCTION

Patients often require a rapid sequence intubation technique during emergencies or electively to protect against aspiration, raised intracranial pressure (ICP) or to facilitate intubation. Rapid sequence intubation involves the administration of a hypnotic and paralytic agent that has rapid onset of action.¹ The neuromuscular agent improves the overall conditions of intubation and success rate of first attempt intubation. It is important to have fast acting medications to allow physicians to complete this procedure quickly and safely.

During surgical procedures endotracheal intubation is an important procedure of administration of anaesthesia. It is important for anaesthesiologists to reduce the airway injuries associated with endotracheal intubation. Adequate depth of anaesthesia and muscle relaxation produce good intubating conditions. Neuromuscular blocking agents are commonly used to facilitate tracheal intubation. An ideal muscle relaxant should have rapid onset, profound relaxation of all muscles and short duration of action.

Succinylcholine, a depolarizing muscle relaxant with its rapid onset and short duration of action is still the relaxant of choice to facilitate tracheal intubation, drug of choice for intubation since its introduction in 1952.

Succinylcholine has many side effects like,

- Increase in intragastric, intracranial and intraocular pressure.
- Rhabdomyolysis with hyperkalemia.
- Changes in cardiac rhythm including bradycardia and cardiac arrest.
- Malignant hyperthermia in susceptible individuals.
- Life threatening increase in serum potassium levels seen in patients with burns, massive trauma, denervating injuries and upper motor neuron lesions.

Therefore, it is contraindicated in patients with head injury, eye injury, patients having recent history of burns and patients with denervating injuries.

Because most of the side effects of Succinylcholine reflect its depolarizing mechanism of action, search for ideal neuromuscular blocking agent focused on nondepolarizing type of relaxants which has rapid onset time

and offers good to excellent intubating conditions, as rapidly as Succinylcholine and which lacks the above mentioned adverse effects. Nondepolarizing neuromuscular blocking agents like Pancuronium, Vecuronium and Atracurium have been used for endotracheal intubation, but more time has been taken for achieving favorable intubating conditions with these agents.

Rocuronium, a new aminosteroidal neuromuscular blocking agent related structurally to Vecuronium. The new nondepolarizing neuromuscular muscle relaxant drug Rocuronium introduced in 1994 became the first competitor for Succinylcholine. Rocuronium has proven its onset time and intubation condition are comparable with Succinylcholine and without the side effects.^{3,2}

Rocuronium proved to be a safe alternative to Succinylcholine for endotracheal intubation.^{5,4} An alternative drug suggested and used in recent times for rapid sequence induction is injection Rocuronium bromide in dose of 0.6-1.2 mg/kg. Its main advantage over other currently used muscle relaxants of this kind is its fast onset of action, an intermediate duration of action and rapid recovery. It provides good to excellent intubating conditions at 60-90 seconds at doses having minimal or no haemodynamic changes. Many studies have shown that the onset of action of Rocuronium is significantly faster when compared to equipotent doses of other nondepolarizing agents.

MATERIALS AND METHODS

Study design: Randomized, prospective and comparative study

Total 60 patients undergoing rapid sequence intubation randomly divided into injection Rocuronium bromide (0.9 mg/kg) (group A) and injection succinyl choline (group B) with 30 patients in each group.

Inclusion criteria :

- Adults between 18 - 60 years
- Weighing between 50 - 70 kgs.
- ASA grade status I or II
- Mallampati grade I or II
- Elective surgeries posted under general anaesthesia

Exclusion criteria:

- Obesity
- Children
- Known/suspected difficult Intubation
- Renal/Hepatic disorder
- Severe metabolic/electrolyte/acid-base disturbances
- History of any neuromuscular disorder
- Known allergy to drugs
- Surgical procedures of very short duration
- Patients receiving any medication known to interact with Neuromuscular blocking agent.

All the patients underwent a thorough pre-anaesthetic check up with necessary investigations. The fasting time was taken as the time interval between the last meal/drink and the time of surgery. Complete physical examination and Airway assessment was done. Informed consent was obtained from all the patients and they were divided into 2 groups, GROUP A (n=30) patients receiving injection Rocuronium bromide (0.9 mg/kg) & GROUP B (n=30) patients receiving injection Succinylcholine chloride (2 mg/kg). To ascertain the ease of intubation, every patient was examined for Mallampati classification⁶ (Young and Samson modification).

In the operation theatre, monitors were applied ECG. Non invasive blood pressure Pulse oximeter. Emergency resuscitation equipments prepared:

- The anaesthesia workstation: Drager.
 - Oxygen source with Bain's circuit and appropriate size masks.
 - Working laryngoscopic blades of appropriate sizes.
 - Endotracheal and tracheostomy tubes.
 - Working suction apparatus.
 - Intravenous crystalloid and colloid infusion bottles.
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Venous access was established and an infusion of crystalloid solution was started.

In Premedications: Injection Glycopyrrolate (0.004 mg/kg) and Injection Fentanyl (2 microgram/kg) IV slowly 5 min before induction. Then after Pre-oxygenated with 100% O₂ by face mask for 3 minutes Induction done by injection Propofol 2 mg/kg IV

Cricoid pressure was given when Propofol was administered and released following successful tracheal intubation and inflation of the cuff. Where the patient had a Ryle's tube inserted prior to induction, Sellick's maneuver was carried with Ryle's tube in-situ.

In-GROUP A, Injection Rocuronium bromide was given in a dose of 0.9 mg/kg

In-GROUP B, Injection Succinylcholine chloride was given in a dose of 2 mg/kg.

60 seconds after injection of muscle relaxant, the patients were intubated with an oral portex cuffed endotracheal tube. Simultaneously, intubating conditions were noted and scored adopted by Cooper et al criteria as shown below.

Cooper et al criteria

| SCORE | JAW RELAXATION | VOCAL CORDS POSITIONS | RESPONSE TO INTUBATION |
|-------|---------------------|-----------------------|-------------------------------|
| 0 | Poor (Impossible) | Closed | Severe Bucking Or Coughing |
| 1 | Minimal (Difficult) | Closing | Mild Coughing |
| 2 | Moderate (Fair) | Moving | Slight Diaphragmatic Movement |
| 3 | Good (Early) | Open | None |

TOTAL SCORE FOR INTUBATING CONDITION:

SCORE:

8-9 = EXCELLENT, 6-7 = GOOD } CLINICALLY ACCEPTABLE

3-5 = POOR, 0-2 = BAD } CLINICALLY UNACCEPTABLE

After inflating the cuff of the endotracheal tube, the patient was maintained with controlled ventilation. The following haemodynamic parameters: heart rate, systolic blood pressure, diastolic blood pressure, mean arterial pressure, SpO₂ were recorded. All patients maintenance with 50% O₂ + 50% N₂O + sevoflurane and Injection Atracurium, and reversed with injection Glycopyrrolate and Injection Neostigmine.

STATISTICAL ANALYSIS:

All observations were recorded and results were analyzed statistically. Data was expressed as mean ± standard deviation and percentage. For comparing numerical data between two groups, Unpaired T-Test was used and Categorical variables were compared with Chi Square Test. 'p' value calculated. 'p' value of < 0.05 interpreted as clinically significant, whereas 'p' value of <0.001 was taken as highly significant. 'p' value of >0.05 is interpreted as clinically non significant.

RESULTS: Total 60 patients undergoing rapid sequence intubation were studied.

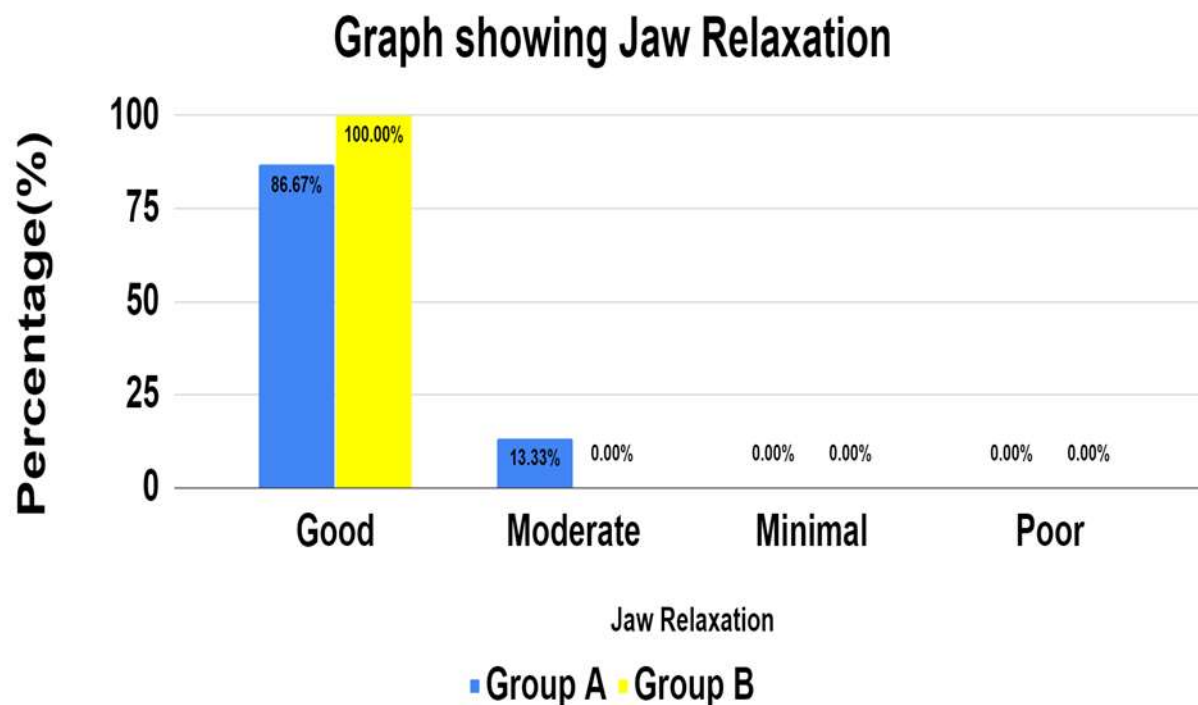
TABLE - 1 Demographic data

| Parameter | Group A | | Group B | | p Value | Inference |
|--------------|---------|--------|---------|--------|---------|-----------|
| | Mean | SD | Mean | SD | | |
| Age (years) | 38.03 | 11.01 | 36.77 | 10.71 | >0.05 | NS |
| Weight (kgs) | 58.43 | 5.08 | 57.73 | 5.13 | >0.05 | NS |
| Sex | No. | % | No. | % | - | - |
| | Male | 16 | 53.33% | 16 | | |
| Female | 14 | 46.67% | 14 | 46.67% | | |
| ASA Grade | No. | % | No. | % | - | - |
| | ASA I | 24 | 80.00% | 23 | | |
| ASA II | 6 | 20.00% | 7 | 23.33% | | |

| Mallampati Grade (MPG) | Group A | | Group B | | p Value | Inference |
|------------------------|---------|--------|---------|--------|---------|-----------|
| | No. | % | No. | % | | |
| MPG I | 26 | 86.67% | 25 | 83.33% | - | - |
| MPG II | 4 | 13.33% | 5 | 16.67% | | |

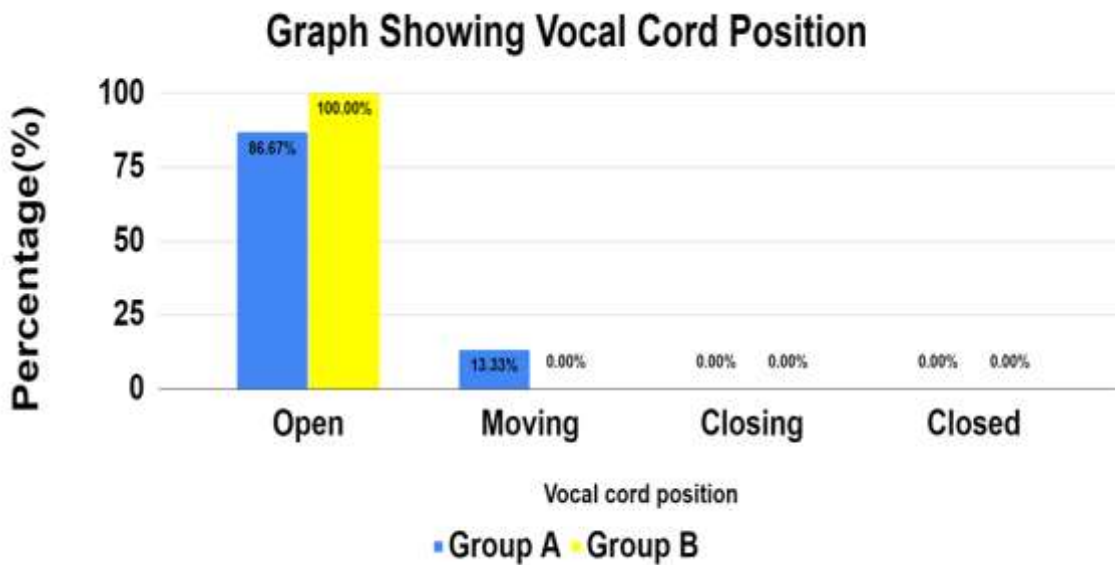
This table shows that age distribution, weight distribution, sex distribution are comparable in both groups. Patients belonging to ASA grade I/II were included in the study. Patients belonging to Mallampati grade I/II were included in the study.

Graph - 1 Jaw Relaxation according to Cooper et al criteria



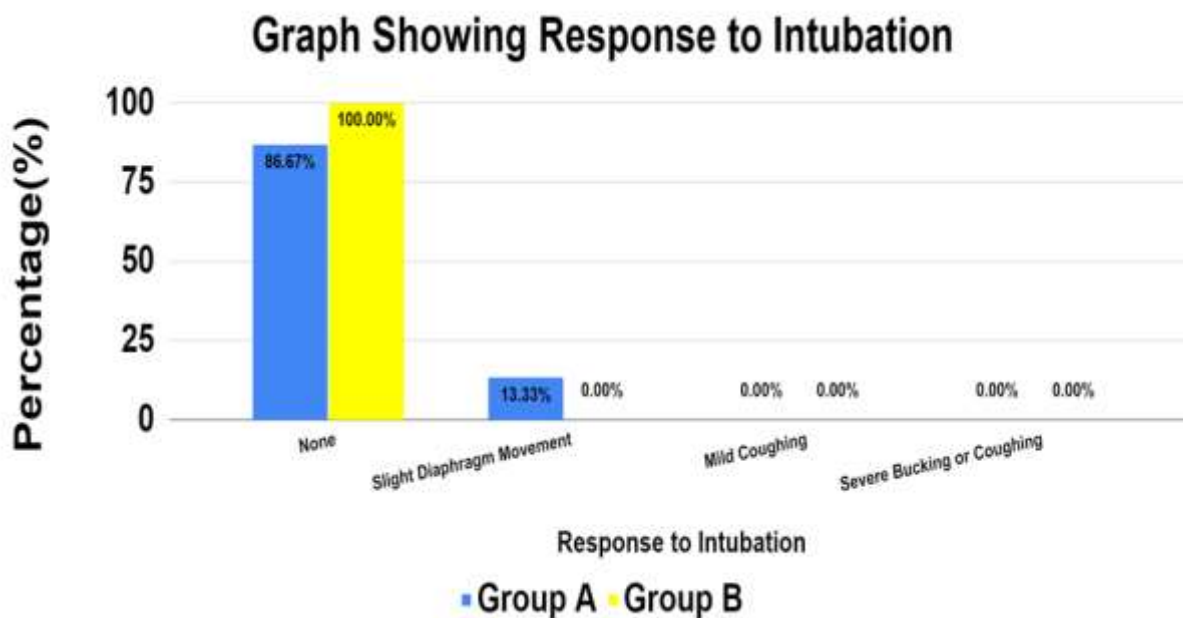
Graph shows that jaw relaxation were good seen in 86.67% patients and 100% patients in group A and group B respectively. While moderate jaw relaxation were seen in 13.33% patients and 0% patients in group A and group B respectively. None of the patients in both groups showed minimal and poor jaw relaxation.

Graph -2 Vocal cord position according to Cooper et al criteria



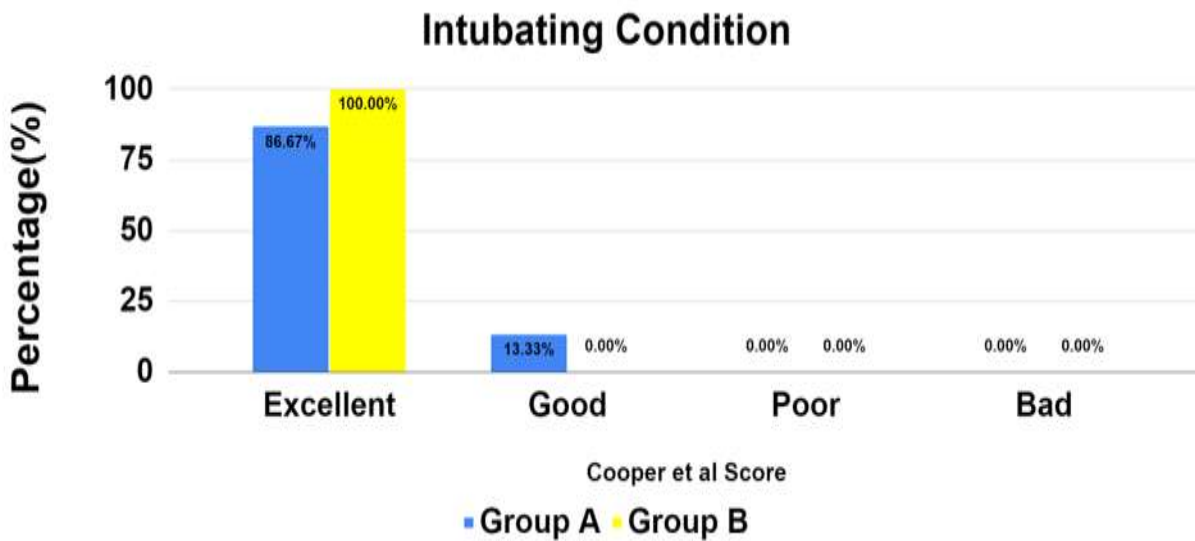
Graph shows that open vocal cords were seen in 86.67% patients and 100% patients in group A and group B respectively. While moving vocal cords were seen in 13.33% patients and 0% patients in group A and group B respectively. None of the patients in both groups showed closing and closed vocal cords.

Graph -3 Response to intubation according to Cooper et al criteria



Graph shows that no response to intubation was seen in 86.67% patients and 100% patients in group A and group B respectively. While slight diaphragmatic movements were seen in 13.33% patients and 0% patients in group A and group B respectively. None of the patients in both groups showed mild coughing and severe bucking or coughing vocal cords.

Graph-4 Intubating condition



Graph shows that excellent intubating conditions were seen in 86.67% patients and 100% patients in group A and group B respectively. While good intubating conditions were seen in 13.33% patients and 0% patients in group A and group B respectively. None of the patients in both groups showed poor and bad intubating condition.

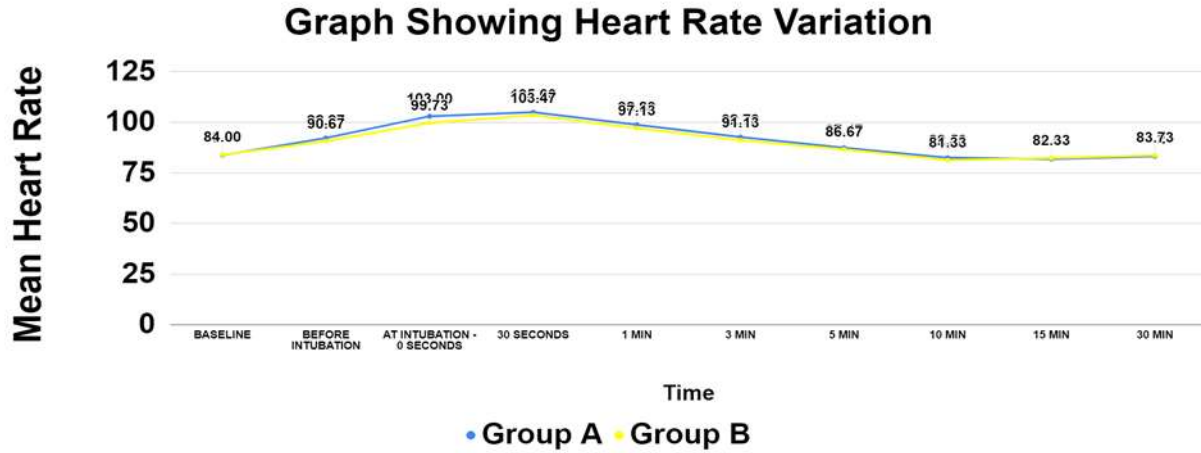
TABLE – 2

| Condition | Score | Group A | | Group B | |
|-------------------------|-------|---------|-------|---------|-------|
| | | No. | % | No. | % |
| Clinically acceptable | 6-9 | 30 | 100% | 30 | 100% |
| Clinically unacceptable | 0-5 | 0 | 0.00% | 0 | 0.00% |

Table shows that clinically acceptable intubating condition were seen in 100% patients in both groups.

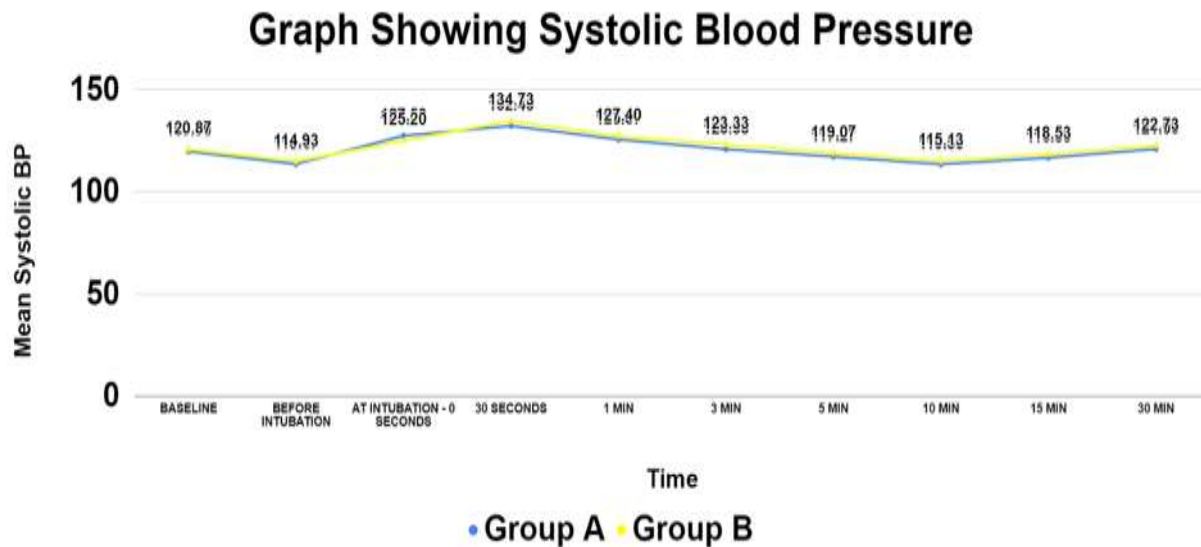
While clinically unacceptable intubating condition were seen in 0% patients in both groups.

Graph-5 Perioperative changes in Heart Rate Variation(mean)(beats per minutes)



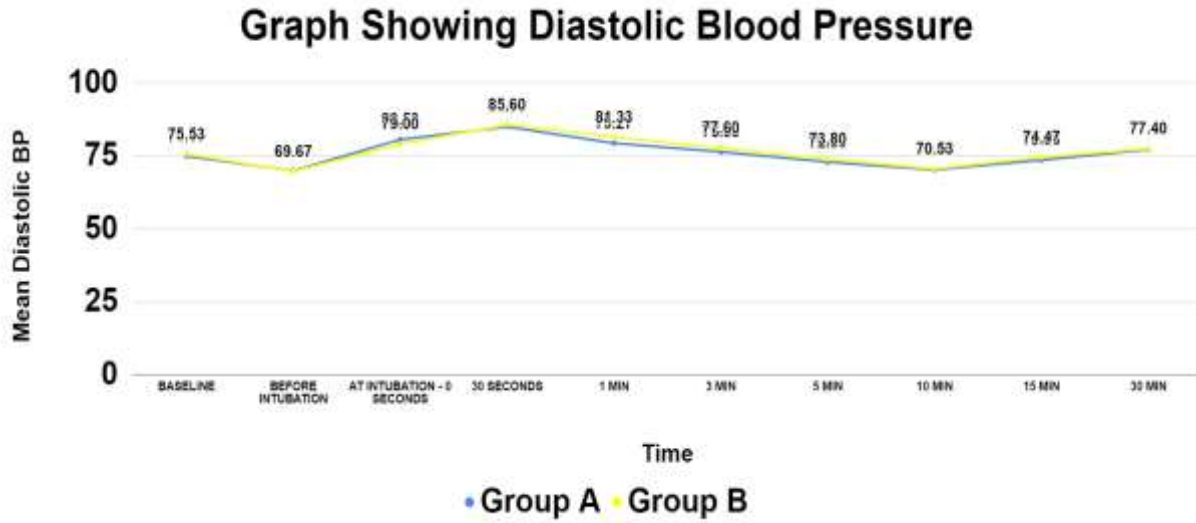
Graph shows that there was no statistical significant difference in heart rate (beats/min) variation in both groups as per time .

Graph-6 Perioperative changes in Systolic blood pressure(mmhg)



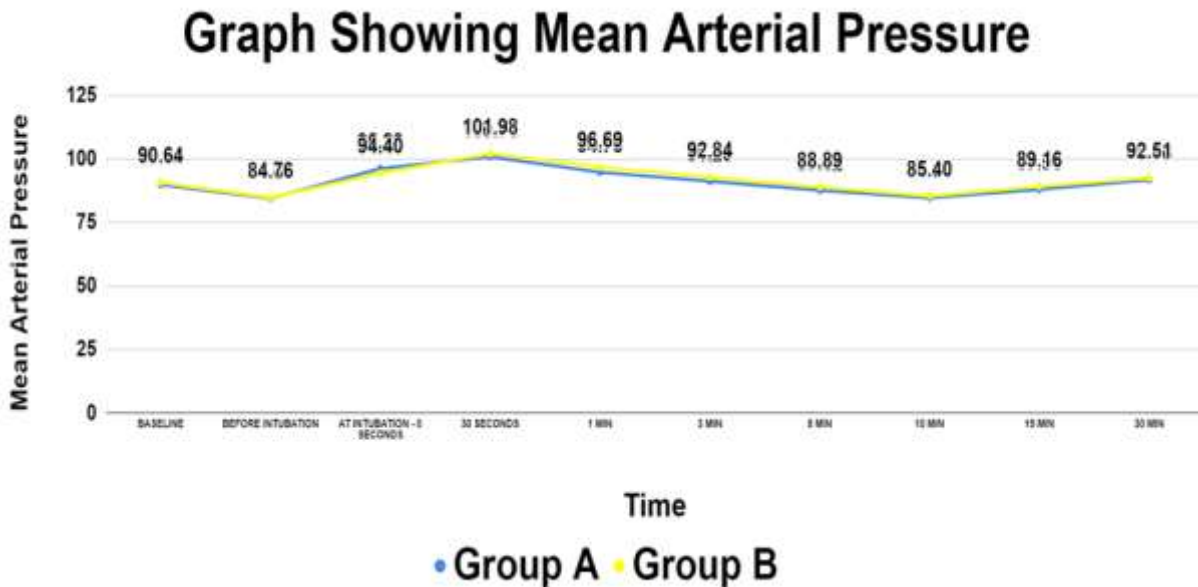
Graph shows that there was no statistical significant difference in systolic blood pressure (mmHg) variation in both groups as per time..

Graph-7 Perioperative changes in Diastolic blood pressure(mmhg)



Graph shows that there was no statistical significant difference in diastolic blood pressure (mmHg) variation in both groups as per time.

Graph-8 Perioperative changes in Mean blood pressure(mmhg)



Graph shows that there was no statistical significant difference in mean arterial pressure (mmHg) variation in both groups as per time.

DISCUSSION

The rapid sequence induction (RSI) involves the rapid sequential administration of medications (including sedatives, induction anaesthetics and muscle relaxant, with or without narcotic) followed by endotracheal intubation within one minute of administering the muscle relaxant. Rapid sequence induction and intubation (often simply referred to as rapid sequence induction in the anaesthesia literature) is a specialized method of intravenous (IV) induction commonly used when an increased risk of gastric regurgitation and pulmonary aspiration of gastric contents exists. After adequate preoxygenation and while cricoid pressure is applied, an induction dose of IV anesthetic is rapidly followed by 1 to 1.5 mg/kg of IV Succinylcholine, and the trachea is intubated without attempts at positive pressure ventilation (PPV). The goal is to achieve optimal intubating conditions rapidly within 60 to 90 seconds to minimize the length of time between the loss of consciousness (LOC) and securing of the airway with a cuffed endotracheal tube (ETT). Cricoid pressure, eponymously referred to as the Sellick maneuver after the physician who first described it, involves the application of pressure at the cricoid ring to occlude the upper esophagus, thereby preventing the regurgitation of gastric contents into the pharynx.¹⁴ For smooth endotracheal intubation neuromuscular blocking agents are required during general anaesthesia. There are maximum chances of hypoxia, regurgitation and aspiration after induction of anaesthesia and before tracheal intubation with cuffed endotracheal tube. So, muscle relaxant should be such that it facilitates early intubation to decrease the chances of hypoxia and regurgitation. Smooth endotracheal intubation demands a drug for muscle relaxation that can provide good to excellent intubating conditions, as early as possible, with minimal side effects and stable haemodynamic profile. Succinylcholine is the drug of choice for this purpose since its introduction in 1952 for endotracheal intubation. Dose of Succinylcholine 1-1.5 mg/kg provide excellent intubating condition in 60-90 seconds with short duration of action. But, it has many side effects and also contraindicated in certain cases. Other nondepolarising muscle relaxants such as Atracurium and Vecuronium have slow onset of action and Atracurium also causes adverse effects like histamine release that causes circulatory changes such as increase in heart rate and decrease in mean arterial pressure are encountered. Thus, in search of alternatives, Non depolarising muscle relaxant Rocuronium has emerged which has rapid onset (60-90 seconds), intermediate duration of action depending on dose and also it is free from side effects related to Succinylcholine. The present study was conducted by taking 60 randomly selected patients for various elective surgeries under general anaesthesia belonging to ASA Grade I or II, Mallampatti grade I or II, weighing between 50-70 kgs aged 18 to 60 years of either sex. Patient were divided into 2 groups of 30 patients each. In our study table 1 shows that Age, Weight, Sex, ASA Grading, Mallampati Grading were comparable in each group. ($p > 0.05$) Lenin P, et al (2022)²⁶ had

comparable demographic data. ($p > 0.05$) In our study, all the patients were premedicated with Injection Glycopyrrolate 0.004 mg/kg IV and Injection Fentanyl 2 microgram/kg IV 5 minutes before induction of anaesthesia. Glycopyrrolate is used as antisecretory agent. By giving Fentanyl as premedication for blunting sympathetic response to laryngoscopy during intubation.

Cooper et al (1992)³ Used Fentanyl as premedication. After 60 seconds of giving Rocuronium and Succinylcholine, intubating conditions were assessed and patients were intubated.

We have used Cooper et al criteria for assessment and grading of intubating conditions with injection Rocuronium bromide 0.9 mg/kg and injection Succinylcholine chloride 2 mg/kg according to group at 60 seconds. Neuromuscular monitoring at time of intubation may be misleading because the onset of neuromuscular block is significantly faster at diaphragm and laryngeal adductor than adductor pollicis. Onset of blockade occurs one to two minutes earlier in the larynx than adductor pollicis. So we have not used neuromuscular monitoring at 60 seconds to assess intubating condition.^{8,9} Graph no 1,2,3 shows jaw relaxation, vocal cord position, response to intubation in both groups. Graph 4 and table 2 shows intubating conditions according to Cooper et al criteria in both groups. The intubating conditions achieved in this study are as under: In Group A Rocuronium (0.9 mg/kg): - 86.67% of patients had excellent intubating condition. - 13.33% of patients had good intubating condition. And none of patients in group A showed poor or bad intubating condition. i.e. 100% patients had clinically acceptable and

0% patients had clinically unacceptable intubating condition. In Group B Succinylcholine (2 mg/kg): - 100% patients had excellent intubating condition. And none of patients in group B showed good, poor or bad intubating condition. i.e. 100% patients had clinically acceptable and 0% patients had clinically unacceptable intubating condition.

So, Rocuronium in the dose of 0.9 mg/kg and Succinylcholine in the dose of 2 mg/kg offers better clinically acceptable intubating condition at 60 seconds.

Copper et al (1992)³ They found intubating conditions after Rocuronium bromide 0.6 mg/kg were clinically acceptable (good or excellent) in 95% of patients at 60 seconds and in all patients at 90 seconds and in all patients at both times after Suxamethonium chloride. Stephan C Marsch, Luzius Steiner, et al (2011)¹⁰ Conclude that in critically ill patients undergoing emergent RSI, incidence and severity of oxygen desaturations, the quality of intubation conditions, and incidence of failed intubation attempts did not differ between Succinylcholine 1 mg/kg and Rocuronium 0.6 mg/kg. Bhaidas Onkar Patil et al. (2019)¹¹ Conclude

that intubation from Rocuronium bromide at a dose of 0.9 mg/kg is comparable to Succinylcholine 1.5 mg/kg at 1 minute. Rocuronium bromide 0.9 mg/kg can be used safely in patients where Succinylcholine is contraindicated. Lenin P, et al (2022)⁷ No differences were noted in regards to the intubating conditions when Succinylcholine 1.5 mg/kg and Rocuronium 0.8 mg/kg were compared. Anaesthesia was maintained with oxygen, nitrous oxide, sevoflurane and Injection Atracurium. In hemodynamic parameters. In this study as shown in graph, in group A the baseline heart rate was 83.73 ± 12.37 . It increased after induction and maximum increase in heart rate occurred 30 seconds after intubation which was 105.00 ± 13.18 , it came to near normal of baseline value which was 87.47 ± 10.88 5 min after intubation. Similarly, in group B the baseline heart rate was 84.00 ± 9.95 . It increased after induction and maximum increase in heart rate occurred 30 seconds after intubation which was 103.47 ± 11.64 , it came to near normal of baseline value which was 86.67 ± 10.23 5 min after intubation.

The changes of heart rate in group A and group B almost similar, but changes in both groups were not statistically significant. ($p > 0.05$) In this study as shown in graph in group A the baseline systolic blood pressure was 119.80 ± 7.23 . It increased after induction and maximum increase in systolic blood pressure occurred 30 seconds after intubation which was 132.40 ± 4.25 , it came to near normal of baseline value which was 117.27 ± 6.36 5 min after intubation. Similarly, in group B the baseline systolic blood pressure was 120.87 ± 5.62 . It increased after induction and maximum increase in systolic blood pressure occurred 30 seconds after intubation which was 134.73 ± 4.83 , it came to near normal of baseline value which was 119.07 ± 5.27 5 min after intubation.

The changes of systolic blood pressure in group A and group B almost similar, but changes in both groups were not statistically significant. ($p > 0.05$)

In this study as shown in graph in group A the baseline diastolic blood pressure was 74.87 ± 5.79 . It increased after induction and maximum increase in diastolic blood pressure occurred 30 seconds after intubation which was 84.93 ± 3.35 , it came to near normal of baseline value which was 72.80 ± 4.83 5 min after intubation. Similarly, in group B the baseline diastolic blood pressure was 75.53 ± 6.80 . It increased after induction and maximum increase in diastolic blood pressure occurred 30 seconds after intubation which was 85.60 ± 6.02 , it came to near normal of baseline value which was 73.80 ± 5.52 5 min after intubation. The changes of diastolic blood pressure in group A and group B almost similar, but changes in both groups were not statistically significant. ($p > 0.05$) In this study as shown in graph in group A the baseline mean arterial

pressure was 89.84 ± 4.26 . It increased after induction and maximum increase in mean arterial pressure occurred 30 seconds after intubation which was 100.76 ± 2.67 , it came to near normal of baseline value which was 87.62 ± 3.75 5 min after intubation. Similarly, in group B the baseline mean arterial pressure was 90.64 ± 4.79 . It increased after induction and maximum increase in mean arterial pressure occurred 30 seconds after intubation which was 101.98 ± 4.45 , it came to near normal of baseline value which was 88.89 ± 3.68 5 min after intubation. The changes of mean arterial pressure in group A and group B almost similar, but changes in both groups were not statistically significant. ($p > 0.05$)

From the above, changes in heart rate, systolic blood pressure, diastolic blood pressure and mean arterial pressure following intubation with Rocuronium and Succinylcholine is minimal. Statistical analysis revealed that there was no statistically significant difference with regard to mean heart rate, systolic blood pressure, diastolic blood pressure and mean arterial pressure during intubation in both groups. Neerja Bharati et al (1999)¹² Studied the haemodynamic effects and intubating conditions after rocuronium and succinylcholine. They concluded that rise in heart rate and mean arterial pressure after intubation was present in the both groups and was comparable between both groups.

Aparna Shukla et al (2004)⁴ Compared the haemodynamic effects of Rocuronium with that of Succinylcholine and concluded that there was no significant change in pulse rate and mean arterial pressure between both. Ajeet Singh, Bhatia Pradeep Kumar, Tulsiani Kishan Lal (2004)¹³ The haemodynamic conditions observed during intubation were comparable with the results Lenin P, et al (2022)⁷ Succinylcholine 1.5 mg/kg produced similar haemodynamic changes with that of rocuronium 0.8 mg/kg. All patients in each group had normal SpO₂ throughout the study. No complications related to procedure like airway injuries associated with laryngoscopy and no complications related to drugs were observed in any group.

CONCLUSION

Though Succinylcholine is the muscle relaxant of choice for rapid sequence intubation, but in new era nondepolarizing neuromuscular blocking agent Rocuronium 0.9 mg/kg can also provide excellent intubating condition as well as stable haemodynamics as compared to Succinylcholine 2 mg/kg for rapid sequence endotracheal intubation at 60 seconds and can be used as alternative to Succinylcholine 2 mg/kg in cases where Succinylcholine is contraindicated.

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