COMPARATIVE STUDY OF ROCURONIUM AND SUXAMETHONIUM IN ENDOTRACHEAL INTUBATION

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ABSTRACT

BACKGROUND

Tracheal intubation is one of the best methods of securing a patent airway. Good intubating conditions minimise the risk of trauma associated with tracheal intubation. Intubating conditions (muscle tone, vocal cords position, reaction to laryngoscopy and tube positioning) depend on depth of anaesthesia and kind of anaesthetic used. Tracheal intubation is commonly facilitated by muscle relaxation. Rocuronium has rapid onset of action, which is comparable to suxamethonium. It has been shown to produce intubating conditions similar to those produced by suxamethonium. This study compares rocuronium and suxamethonium in tracheal intubation.

MATERIALS AND METHODS

A total of 100 patients of ASA grade 1 and 2 for elective surgeries under general anaesthesia were recruited for this study after obtaining clearance from institutional ethics committee and informed consent from the patients. These 100 patients were divided into 2 groups, group R received rocuronium and group S received suxamethonium. All patients underwent through pre-anaesthetic checkup on the day before surgery. Thorough airway assesssment was done to rule out difficult intubation. Patients were advised to be nil orally from 10 p.m. onwards, the night before surgery.

RESULTS

The intubating conditions in the rocuronium group were found to be excellent in 50%, fair in 34% and satisfactory in 16% of the patients compared to excellent in 68%, fair in 32% in suxamethonium group. Clinically, acceptable intubating conditions were seen in 84% and 100% of patients administered rocuronium and suxamethonium, respectively.

CONCLUSION

Rocuronium in a dose of 0.6 mg/kg is a suitable alternative to suxamethonium in a dose of 1.5 mg/kg in premedicated and anaesthetised patients scheduled for elective surgeries.

KEYWORDS

Endotracheal Intubation, Laryngoscopy, Intubation Score, Succinylcholine, Rocuronium, Rapid Sequence Intubation, Muscle Relaxant.

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BACKGROUND

Tracheal intubation is one of the best methods of securing a patent airway. Good incubating conditions minimise the risk of trauma associated with tracheal intubation. Patients often require a Rapid Sequence Induction (RSI) endotracheal intubation technique during emergencies or electively to protect against aspiration, increased intracranial pressure or to facilitate intubation.[1]

Intubating conditions (muscle tone, vocal cords position, reaction to laryngoscopy and tube positioning) depend on depth of anaesthesia and kind of anaesthetic used. Tracheal intubation is commonly facilitated by muscle relaxation.

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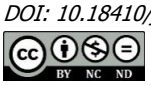


An ideal muscle relaxant should have non-depolarising mechanism of action, rapid onset, short duration, rapid recovery, non-cumulative, antihistaminic release, no cardiovascular side effects, high potency and prompt reversibility by cholinesterase inhibitors and pharmacologically-inactive metabolites. Suxamethonium, a deploarising muscle relaxant is the most commonly used and considered the gold standard for tracheal intubation. The popularity of suxamethonium is questioned due to its many side effects varying in seriousness from patient discomfort due to postoperative myalgia upto potentially life-threatening events such as arrhythmias and malignant hyperthermia. One of the main reasons for the popularity of suxamethonium is its propensity to create good intubating conditions rapidly. This increases safety, since it allows early establishment of patent airway reducing the risk of aspiration. With advent of newer non-depolarising muscle relaxants, anaesthesiologists have other options where suxamethonium is contraindicated.

Hence, a non-depolarising neuromuscular blocker with a rapid onset of action, preferably of a shorter duration is desirable, the quality, which rocuronium is supposed to have.[2]

Rocuronium (ORG 9426), a new non-depolarising aminosteroidal muscle relaxant is chemically 2-morpholino, 3-desacetyl, 16-N-allyl pyrrolidino derivative of vecuronium differing from it at 3 positions on steroid nucleus. Rocuronium has a rapid onset time, an intermediate duration of action and rapid recovery with cardiovascular stability, no significant histamine release.[3]

Rocuronium has been shown to produce intubating conditions similar to those produced by suxamethonium. This study compares rocuronium and suxamethonium in tracheal intubation.

AIM

This study is designed to compare the drugs rocuronium bromide and suxamethonium in tracheal intubation and further to evaluate whether rocuronium bromide can be an acceptable alternative to suxamethonium.

The aim of the study is to compare and evaluate the effects of intubating doses of rocuronium bromide and suxamethonium in respect to-

- Onset of action.
- Intubating conditions.
- Duration of action.
- Haemodynamic effects.
- Side effects.

MATERIALS AND METHODS

This study was conducted during the period from June 2014 to May 2016 at Maharajah's Institute of Medical Sciences, Vizianagaram. A total of 100 patients of ASA grade 1 and 2 scheduled for elective surgeries under general anaesthesia were recruited for this study after obtaining an informed consent and were divided into 2 groups 50 in each group. Group R received rocuronium and group S received suxamethonium.

Pre-Anaesthetic Checkup

All patients underwent pre-anaesthetic checkup on the day before surgery. General physical examination and thorough airway examination was done. Any previous history of difficult intubation was asked and such patients were excluded from the study. Systemic examination included thorough cardiovascular, respiratory, central nervous and per abdominal examination to rule out an associated pathology. Routine laboratory investigations were ordered and patients fit for surgery were advised to be nil orally from 10 p.m. onwards, the night before surgery.

Premedication

All patients were premedicated with Tab. Diazepam 5 or 10 mg orally the night before surgery depending upon patient's age and weight.

On the morning of surgery in the pre-anaesthetic room, an intravenous line was secured with appropriate size IV cannula. Baseline heart rate, systolic, diastolic and mean arterial pressures were recorded and designated as resting values. All patients were given Inj. Midazolam 0.07-0.08 mg/kg IM and Inj. Pentazocine 0.3 mg/kg IM 30 minutes prior to surgery.

On arrival of patient in the operation theatre, the patency of the IV cannula was checked and started 5% dextrose with normal saline infusion. Monitors were connected.

Anaesthesia Technique

All patients were preoxygenated with 100% oxygen for 3-5 minutes. Anaesthesia was induced with Inj. Propofol 2 mg/kg IV and Inj. Glycopyrrolate 0.01 mg/kg IV. Propofol was used as the induction drug, because this anaesthetic seems to be superior to all other drugs with regard to intubating conditions after rocuronium injection. Fentanyl 2 mg/kg was added to the induction sequence because opioids were found to significantly improve intubating conditions after rocuronium administration.[4]

Heart rate, systolic, diastolic and mean arterial pressures were recorded and designated as values after induction.

Group R received Inj. Rocuronium bromide 0.6 mg/kg as muscle relaxant and Group S received Inj. Suxamethonium 1.5 mg/kg as muscle relaxant.

Patients were ventilated with 100% oxygen for 60 seconds. At the end of 60 seconds, laryngoscopy was performed and intubating conditions were graded depending upon jaw relaxation, mouth opening, position and movement of vocal cords and response to tube as follows-

Intubating Conditions, Rating Scale by Lund and Stovner[5]

Classification	Jaw Relaxation and Mouth Opening	Vocal Cords Visualisation	Vocal Cords Position	Vocal Cords Movement	Response to Tube
Excellent	Flaccid relaxation, mouth wide open	Good	Abducted	Paralysed	None
Fair	Well relaxed, mouth easily opened	Good	Abducted	Slight cord movement	Minimal bucking at intubation for brief period
Satisfactory	Not well relaxed, mouth opening less favourable	Fair	Abducted	Slight cord movement	Bucking and straining
Impossible	Poor relaxation, resistance to mouth opening	Poor or none	Abducted	Closed	Marked bucking and body movement

Excellent and fair groups were considered as clinically acceptable intubating conditions.

Following intubation of trachea, the endotracheal tube was fixed and connected to breathing circuit. Anaesthesia was maintained with nitrous oxide (60%), oxygen (40%), 0.4-0.8% isoflurane and with vecuronium. The patients were given intermittent positive pressure ventilation. The changes in heart rate, systolic, diastolic and mean arterial pressures were measured and recorded at 1, 3, 5 and 10 minutes after intubation.

At the end of surgery, neuromuscular blockade was reversed with Inj. Neostigmine 0.05 mg/kg and Inj. Glycopyrrolate 0.01 mg/kg IV. The patients were extubated after thorough suctioning. Any untoward side effects like skin flush, erythema and itching was recorded.

Statistical Analysis

Descriptive statistics that included mean, SD, minimum and maximum values were calculated for each of the two study groups. The study was used to determine whether significant differences were present in the different variables between the two study groups. Significance for all statistical tests were predetermined at a probability value (P - value <0.05). Only significant values have been mentioned.

RESULTS

Anthropometric Details of Patients	Group R	Group S
Number of cases	50	50
Sex Male Female	 29 21	 21 29
Age - Mean ± SD	28.36 ± 13.59	29.1 ± 11.08
Weight (kg) Mean ± SD	48.66 ± 13.94	51.24 ± 9.41

Table 1. Anthropometric Details of Patients

Age Group (Years)	Group R	Group S
11-20	19	13
21-30	8	16
31-40	10	11
41-50	13	10
Range	11-50	11-50
Mean ± SD	28.36 ±13.59	29.1 ± 11.08

Table 2. Age Distribution of Patients

Age Group (kg)	Group R (n=50)	Group S (n=50)
20-30	9	2
31-40	6	5
41-50	7	22
51-60	23	18
61-70	5	3
Range	20-70	22-65
Mean ± SD	48.66 ± 13.94	51.24±9.41

Table 3. Weight Distribution of Patients

Groups	Onset Time (secs.)
Group R	60.0
Group S	60.0

Table 4. Onset of Action

Intubating Conditions	Group R (n=50)	Group S (n=50)
Excellent	25 (50%)	34 (68%)
Fair	17 (34%)	16 (32%)
Satisfactory	8 (16%)	0
Impossible	0	0

Table 5. Intubating Conditions After 60 Seconds

Duration of Action (Minutes)	Rocuronium	Suxamethonium	P value
Range	20-40	5-15	<0.001 HS
Mean ± SD	28.9 ± 5.46	8.2 ± 2.93	<0.001 HS

Table 6. Duration of Action (minutes)

Time of Monitoring	Group R Mean ± SD	Group S Mean ± SD
Resting	88.6 ± 15.70	83.58 ± 10.20
After induction	92.7 ± 14.52	94.06 ± 10.71
After intubation 1	110.5 ± 14.97	108.66 ± 9.95
After intubation 3	106.46 ± 11.78	108.18 ± 11.83
After intubation 5	99.82 ± 11.32	103.06 ± 10.82
After intubation 10	95.96 ± 12.58	98.76 ± 10.71

Table 7. Heart Rate Variation

Time of Monitoring	Group R Mean ± SD	Group S Mean ± SD
Resting	119.8 ± 9.15	115.8 ± 7.02
After induction	117.56 ± 9.17	117.6 ± 8.46
After intubation 1	131.56 ± 12.65	126.12 ± 7.67
After intubation 3	126.32 ± 10.28	126.32 ± 10.28
After intubation 5	120.68 ± 10.17	121.48 ± 8.72
After intubation 10	116.72 ± 8.77	119.32 ± 6.89

Table 8. Systolic Blood Pressure Variation

Time of Monitoring	Group R Mean ± SD	Group S Mean ± SD
Resting	76.4 ± 7.49	80.8 ± 7.78
After induction	75.72 ± 7.45	81.8 ± 7.74
After intubation 1	87.48 ± 7.85	86.8 ± 7.40
After intubation 3	83.16 ± 8.40	86.0 ± 7.55
After intubation 5	78.2 ± 7.74	84.32 ± 6.70
After intubation 10	78.36 ± 7.38	83.8 ± 6.96

Table 9. Diastolic Blood Pressure Variation

Time of Monitoring	Group R Mean ± SD	Group S Mean ± SD
Resting	90.62 ± 7.07	91.72 ± 6.93
After induction	89.56 ± 6.75	93.6 ± 7.12
After intubation 1	102.02 ± 8.42	99.72 ± 6.50
After intubation 3	97.4 ± 7.95	99.34 ± 7.15
After intubation 5	92.18 ± 7.35	96.58 ± 6.56
After intubation 10	90.98 ± 7.06	95.46 ± 6.17

Table 10. Mean Arterial Pressure Variation

Total Number Cases	Side Effects	Rocuronium	Suxamethonium	Percentage
Group R (n=50)	Tachycardia	1 case		2
Group S (n=50)	Postoperative myalgia		2 cases	4

Table 11. Side Effects

DISCUSSION

The airway of the anaesthetised patient is unprotected and very vulnerable to aspiration of pharyngeal contents. Hence, the securing of the airway is of prime importance in all patients especially with those who have full stomach have delayed gastric emptying times or have impaired function of the lower oesophageal sphincter. It has long been used for rapid onset of intubating conditions, but has many undesirable adverse effects because of its depolarising mechanism of action. It is contraindicated in patients with raised intracranial pressure, hyperkalaemia, burns and arrhythmia patients with history of malignant hyperthermia and in patients with abnormal activity of pseudocholinesterase. Rocuronium has been shown to produce intubating conditions within 60 seconds following its administration similar to those produced by suxamethonium. In this study, we have compared rocuronium bromide and suxamethonium for tracheal intubation and evaluated whether rocuronium can be an acceptable alternative to suxamethonium with regard to various parameters.

Intubating Dose

In our present study, we have used 2*ED95 (0.6 mg/kg) of rocuronium bromide and of suxamethonium as the intubating dose.

A similar dose has been used by Huizinga et al[6] in their comparative study. Rocuronium (0.6 mg/kg) produced good to excellent intubating conditions at 60 seconds as well as 90 seconds after administration. Intubating conditions following suxamethonium 1.5 mg/kg were comparable with those after rocuronium.

Prien et al studied different doses of rocuronium for tracheal intubation and concluded that good-to-excellent tracheal intubating conditions could be achieved not only at the standard intubating dose of 0.6 mg/kg, but also at lower doses of 0.3-0.45 mg/kg. It creates intubating conditions similar to those of suxamethonium and its time of onset of action is comparable with that of suxamethonium. Rocuronium 0.6 mg/kg produced acceptable intubating condition in 100% patients, which was equivalent to suxamethonium in the dose of 1.5 mg/kg at 60 seconds in the study carried out by Puhringer et al 1992[9] and in 80% patients in the study carried out by Shukla et al 2004.[7]

Heier and Caldwell found that rocuronium in a dose of 2.0 mg/kg can produce a >90% probability of achieving perfect conditions for rapid tracheal intubation. If large doses are used in patients who will require prolonged tracheal intubation, such as those with head trauma, then prolonged block is not necessarily a disadvantage.[8]

Onset of Action

In our study, laryngoscopy and intubation was performed at the end of 60 seconds after administration of the neuromuscular blockade. This was in view of comparing the intubating conditions between the two drugs rocuronium and suxamethonium at a particular time. This goes in correlation with other studies[9] who found that rocuronium produced clinically acceptable intubating conditions within 60-90 seconds after administration of the drug.

Intubating Conditions

In our study, we have used the rating scale by Lund and Stovner[5] to assess the intubating conditions.

In rocuronium group, excellent intubating conditions were seen in 50% of patients, fair in 34% patients and satisfactory intubating conditions were seen in 16% patients.

In the suxamethonium group, excellent intubating conditions were seen in 68% and fair intubating conditions in 32% of patients.

Clinically acceptable intubating conditions were seen in 84% and 100% of patients administered rocuronium and suxamethonium, respectively.

Cooper R et al (1992) found that intubating conditions were 100% acceptable at 90 seconds as compared to 95% acceptable at 60 secs. with 0.6 mg/kg rocuronium given in adult patients.

The pooled data of various studies by Mirakhur RK, Cooper AR, Clarke R.S.J.,[10] Huizinga A.C et al[6] and Magorian T et al[11] showed excellent in 78% and 87%, good in 20% and 10%, poor intubating conditions in 2% and 3% of patients after rocuronium and suxamethonium, respectively. Clinically acceptable intubating conditions were seen in 98% and 97% of patients receiving rocuronium and suxamethonium, respectively. The above workers used the rating scale by Krieg et al[12] and Copenhagen consensus conference rating scale.[13] The above workers used a combination of propofol, opioid and benzodiazepine with opioid.

The variations seen in the intubating conditions in our study and by the above workers could be attributed to various factors like-

1. Different rating scale used.
2. Large room for personal and subjective interpretation of data.
3. Different anaesthetic agents used.

Duration of Action

Rocuronium has a range of 20-40 minutes. The mean duration of action was 28.9 ± 5.46 minutes and P value is <0.001, which is statistically significant. Suxamethonium has a range of 5-15 minutes. The mean duration of action was 28.9 ± 5.46 minutes and P value is <0.001, which is statistically significant. This duration of action almost coincides with that reported by Mirakhur RK[10] that overall duration of clinical relaxation is in the range of 23-35

minutes with a dose of 0.6 mg/kg. The mean duration of action of rocuronium is 35 ± 15 minutes to that of suxamethonium is 9 ± 2 minutes.

Cooper R.A, Mirakhur R.K and Maddineni V.R.[14] studied the neuromuscular effects of rocuronium bromide during fentanyl and halothane anaesthesia. They showed that the duration of clinical relaxation was 34 minutes and 33 minutes with fentanyl and halothane, respectively. Cooper R et al[15] in another study compared the intubating conditions after administration of rocuronium and suxamethonium. They reported that the duration of clinical relaxation was 30 minutes.

Haemodynamic Effects

Various haemodynamic parameters like heart rate, systolic blood pressure, diastolic blood pressure and mean arterial pressure were evaluated. All these parameters increased following laryngoscopy and intubation. The maximum increase was at 1 minute after intubation. All the parameters decreased thereafter towards resting values in the two groups. These changes were statistically not significant. Francis F. Folders et al[16] studied the neuromuscular effects of rocuronium in patients receiving balanced anaesthesia. They found that there were no significant changes in heart rate, systolic blood pressure and diastolic blood pressure measured at 1 minute intervals from the start of injection of 0.5 or 0.6 mg/kg rocuronium to the development of its maximal neuromuscular effect. It appears to have no circulatory side effects. E. Abouleish et al[17] in their study observed that there were statistically significant increase in heart rate and arterial pressure 2 minutes after administration of rocuronium coinciding with completion of intubation and skin incision. They however agreed that rocuronium has a very little effect on cardiovascular system.

Side Effects

Tachycardia has been noted in 2% of the rocuronium group and postoperative myalgia noted in 4% of the suxamethonium group. There are very little reports about the side effects of rocuronium. Abouleish E et al[17] observed cutaneous reactions in two patients in their study group. These reactions, however, were transient, localised and mild. The aetiology was not clear, but in neither case could the reaction be ascribed solely to rocuronium.

So, it follows that rocuronium is associated with a fast onset of action, which is comparable to suxamethonium, thus making it suitable alternative to the latter. Rocuronium, however, has a disadvantage having intermediate duration of action with the standard intubating dose of 0.6 mg/kg producing neuromuscular block that lasts for 20-40 minutes. This being the case, its use cannot be recommended in patients with anticipated difficulty in tracheal intubation. A failed intubation in patients given rocuronium can prove dangerous because of its relatively longer duration of action compared to suxamethonium. Suxamethonium with its rapid termination of action 5-10 minutes is a safer agent for use in patients with anticipated difficulty in intubation.

Why Rocuronium is the Agent of Choice for RSI?.[18]

Point #1 - Suxamethonium leads to more rapid oxygen desaturation than rocuronium.

After giving a dose of succinylcholine, we watch for fasciculations. This signifies that the drug has taken effect. It also eats oxygen. A study by Taha et al demonstrated that succinylcholine led to oxygen desaturation 20 seconds faster than rocuronium (Taha 2010). A subsequent study of overweight patients revealed a 46 seconds difference in oxygen desaturation in favour of rocuronium (Tang 2011).

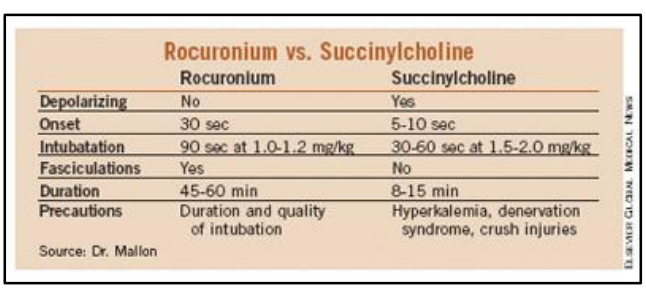
Point #2 - Suxamethonium has the potential to cause life-threatening hyperkalaemia.

Suxamethonium's side effect of raising serum potassium is well-known and accepted. In patients with certain underlying conditions, suxamethonium can cause life-threatening hyperkalaemia leading to dysrhythmias and potentially cardiac arrest.

Unlike suxamethonium, rocuronium does not cause a rise in potassium and has no contraindications to its use.

Finally, rocuronium is neuroprotective. Hypoxia, while bad in all patients, is horrible in head bleeds. A single hypoxic event can double the risk of bad outcomes. Since, suxamethonium leads to more rapid oxygen desaturation (Taha 2010, Tang 2011) the risk of a hypoxic event has increased. Additionally, spikes in Intracranial Pressure (ICP) can potentially worsen outcomes in these patients.

Rocuronium vs. Succinylcholine- Which Is Best? By Robert Finn Elsevier Global Medical News[19]



Rocuronium vs. Succinylcholine

	Rocuronium	Succinylcholine
Depolarizing	No	Yes
Onset	30 sec	5-10 sec
Intubatation	90 sec at 1.0-1.2 mg/kg	30-60 sec at 1.5-2.0 mg/kg
Fasciculations	Yes	No
Duration	45-60 min	8-15 min
Precautions	Duration and quality of intubation	Hyperkalemia, denervation syndrome, crush injuries

Source: Dr. Mallon

CONCLUSION

Rocuronium bromide in a dose of 0.6 mg/kg can be used as an alternative to suxamethonium provided the airway has been carefully assessed and no difficulty is anticipated. Rocuronium is of advantage whenever the interval between the administration of the muscle relaxant and endotracheal intubation must be short when suxamethonium is contraindicated.

To conclude, rocuronium in a dose of 0.6 mg/kg is a suitable alternative to suxamethonium in a dose of 1.5 mg/kg in premeditated and anaesthetised patients scheduled for elective surgeries.

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