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Original article

A COMPARATIVE STUDY OF ROCURONIUM & SUXAMETHONIUM FOR TRACHEAL INTUBATION DURING ELECTIVE SURGICAL PROCEDURES

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ABSTRACT

The aim of the study is to compare intubating conditions using rocuronium with gold standard relaxant suxamethonium and to evaluate intubating conditions with rocuronium using the timing principle. This study was carried out in the department of Anaesthesiology, Patients posted for elective general surgical procedure were included in study. In this study, 96.7% patients in group I (Sch) exhibited excellent intubating conditions. In group II only 63.3% patients exhibited excellent intubating conditions, where timing principle is not followed. In group III and group IV 100% and 96.7% patients exhibited excellent intubating conditions respectively. Good intubating conditions were found in 3.3%, 36.6% and 3.3% patients in group I (Sch), group II and group IV respectively. The excellent and good intubating conditions were considered acceptable whereas the fair and poor intubating conditions were unacceptable. To conclude rocuronium bromide can be considered as an alternative to suxamethonium even if rapid sequence intubation is required.

Introduction

Introduction of newer inhalational agents and muscle agents and muscle relaxants have refined and improved the anaesthetic practice. Thereby it contributes for advanced medical and healthcare facility to human population.

Rapid and safe endotracheal intubation is of paramount importance in the practice of general anaesthesia. The ease with which endotracheal intubation is performed depends upon the degree of muscle relaxation, depth of anaesthesia and the skill of anaesthesiologist.

Aspiration of gastric contents, during induction of anaesthesia is a major factor contributing anaesthetic morbidity and mortality. Endotracheal intubation becomes mandatory to avoid this complication. Theoretically use of muscle relaxant with faster onset would reduce the risk of these effects and so the morbidity.

Traditionally, suxamethonium allowed a rapid sequence induction intubation, the goal of which was to intubate the trachea and thereby protect the airway within 60-90 seconds of administration of induction drug. Suxamethonium's rapid onset time seemed ideal; moreover, it also had brief duration of action (5-10 min). However in addition to fasciculations, suxamethonium has got many side effects such as bradycardia, and other (dysrrhythmias, hyperkalemia, postoperative myalgia, rise in intraocular, intragastric, and intracranial pressure, incidence of prolonged recovery in patients with pseudocholinesterase deficiency and triggering of malignant hyperthermia.

Because most of the side effects of the suxamethonium reflects its depolarising mechanism of action. Therefore search for ideal muscle relaxant focused on nondepolarising type of relaxants which has rapid onset lime and offers well to excellent intubating conditions as rapidly as suxamethonium and which lack above mentioned side effects.

Unlike suxamethonium, rocuronium has little or no cardiovascular effects. Thus it is potentially ideal for fast intubation and probably preferable to suxamethonium.

MATERIALS AND METHODS

This study entitled 'A comparative study of rocuronium & suxamethonium for tracheal intubation during elective surgical procedures' was carried out in the Department of Anaesthesiology, Indira Gandhi Government Medical College and Hospital, Nagpur during the period Mar 06 to July 07.

The objectives of the project were to study various properties of rocuronium:

1. Time of onset of ptosis, (initiation of neuromuscular blockade)
2. To compare intubating conditions using rocuronium with gold standard relaxant suxamethonium.
3. To evaluate intubating conditions with rocuronium bromide in a dose of 0.6 mg/kg at 45 sec and 60 sec using timing principle.
4. To compare intubating conditions using rocuronium without following timing principle.

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Inclusion criteria:

1. ASA grade I/II
2. Either sex
3. 18 -65 yrs
4. Average weight
5. Non-obese
6. Mallampati grade I and II
7. Normal neck mobility

to be taken for elective general surgical procedures under general anaesthesia with endotracheal intubation were selected.

Exclusion criteria:

1. ASA grade III/IV
2. Mallampati grade III/IV
3. Anticipated difficulty with airway management
4. Patient with increased risk of aspiration
5. Contraindications to Suxamethonium/ rocuronium
6. Neuromuscular diseases
7. Medications known to influence neuromuscular function

Preoxygenation was done with 100% O2 for 5 min using magill's circuit.

Thiopentone sodium was used for induction (4-6 mg/kg) in all four groups. End point of induction was loss of eyelash reflex

Schematic presentation of schedule of drugs 5 minutes after premedication:

Group I (Sch)

Induction ⇨ Suxamethonium (1.5 mg/kg)⇨Laryngoscopy & intubation 60 sec after relaxant (immediately after induction)

Group II (TR60)

Induction ⇨ **Rocuronium** (0.6 mg/kg) ⇨ Laryngoscopy & intubation 60 sec after relaxant (immediately after induction)

Group III (R60)

Rocuronium (0.6 mg/kg) ⇨ Induction ⇨ Laryngoscopy & intubation 60 sec after relaxant (at the onset of ptosis)

Group IV (R45)

Rocuronium (0.6 mg/kg) ⇨ Induction ⇨ Laryngoscopy & intubation 45 sec after relaxant (at the onset of ptosis)

The dose of rocuronium was selected as 0.6 mg/kg (2X ED95) as previous studies by Cooper R. et al (1990), Huizinga AC et al (1992) and Puhringer FK (1992) have shown that intubating conditions are generally excellent or good with this dose [1,2,3].

The dose of Suxamethonium was chosen as 1.5 mg/kg as a standard intubating dose.

In group III (R60) and group IV (R45) induction is started at the onset of ptosis. Due to non availability of neuromuscular monitor, ptosis was selected as a parameter of onset of muscle paralysis.

Laryngoscopy and intubation was attempted by experienced anaesthesiologist at 60 sec after relaxant in group I, II and 60 and 45 sec after end point of induction in group III and group IV respectively with proper sized cuffed endotracheal tube.

The intubating condition were evaluated as per following grading criteria by Kreig et al (1980) [4] and Huizinga et al (1992) [2].

Criteria and Score of Intubating Conditions:

Jaw relaxation	Vocal cords	Response to intubation	Score
Poor(impossible)	Closed	Severe coughing bucking	0
Minimal(difficult)	Closing	Mild coughing	1
Moderate(fair)	Moving	Slight diaphragmatic movement	2
Good(easy)	Open	None	3

Each variable was graded on four point scale (0-3) and given a score as above and total score was obtained by adding them. Considering this total intubation score, intubating condition were labelled as follows:

Grading of Intubation:

Intubating condition	Score
Excellent	8-9
Good	6-7
Fair	3-5
Poor	0-2

The excellent and good intubating conditions were taken as acceptable whereas the fair and poor intubating conditions were considered as unacceptable. In the event of failure to intubate in the first attempt oxygenation with 100% O2 continued and intubation attempted after 30 sec.

Intraoperatively anaesthesia was maintained with O2 and N2O (2:3) with halothane or isoflurane and controlled ventilation.

At the end of the surgery residual neuromuscular blockade was reversed with neostigmine 0.05 mg/kg and glycopyrrolate 10 µg/kg IV and patient extubated after ensuring adequacy of reversal.

RESULTS

The mean onset time of ptosis was found to be 22.66 (±8.04) sec in group III (R60) and 23.1(±7.77) sec in group IV (R45). The mean onset time was comparable in both the groups.

In this study, 96.7% (29/30) patients in group I (Sch) exhibited excellent intubating conditions. In group II (TR60) only 63.3% (19/30) patients exhibited excellent intubating conditions, where timing principle is not followed. In group III (R60) and group IV (R45) 100% (30/30) and 96.7% (29/30) patients exhibited excellent intubating conditions respectively. Good intubating conditions were found in 3.3% (1/30), 36.6% (11/30) and 3.3% (1/30) patients in group I (Sch), group II (TR60) and group IV bation, neither the condition of unable to intubate was faced.

(R45) respectively. The excellent and good intubating conditions were considered acceptable whereas the fair and poor intubating conditions were unacceptable.

Thus acceptable intubating conditions were found in 100% (120/120) patients studied. None of the patient in the study required multiple attempts of intu

Table No.1 showing onset time of ptosis

Onset of ptosis (sec)	No. of patients in		Total
	Gr. Ill (R60)	Gr. IV (R45)	
10-19	08	08	16
20-29	17	14	31
30-39	03	07	10
40-49	02	01	03
Total	30	30	60
Mean ± SD	22.66 ± 8.04	23.1 ±7.77	

➢ The onset time of ptosis ranged between 10-45 seconds. The mean onset time of ptosis was 22.66 ± 8.04 sec in GR. Ill (R60) and 23.1 ± 7.77 sec in GR. IV (R45).

➢ The mean onset time of ptosis was comparable in both the groups.

Table No.2 showing intubating conditions and score

Criteria	Score		Gr.I (Sch)	Gr.II TR60)	Gr.III (R60)	Gr.IV (R45)
Jaw Relaxation	Poor	(0)	-	-	-	-
	Minimal	(1)	-	-	-	-
	Moderate	(2)	-	06	01	-
	Good	(3)	30	24	29	30
Vocal Cords	Closed	(0)	-	-	-	-
	Closing	(1)	-	-	-	-
	Moving	(2)	-	04	01	05
	Open	(3)	30	26	29	25
Response To Intubation	Severe Coughing	(0)	-	-	-	-
	Mild Coughing	(1)	1	09		-
	Slight Diaph. Movt	(2)	-	10	02	02
	None	(3)	29	11	28	28

➢ Jaw relaxation was found to be moderate to good in the groups, while all patients in group I and group IV showed good jaw relaxation.

➢ Vocal cords were found to be open in majority of the patients, only 4 patients in group I, 1 patient in group II and 5 patients in group IV showed moving vocal cords.

➢ While none to slight diaphragmatic movement was observed in group III and group IV, 9 patients in group II and 1 patient in group I showed mild coughing.

Table No. 3 showing intubation score

Intubation	No. of patients in			
Score	Gr. I (Sch)	Gr. II (TR60)	Gr. Ill (R60)	Gr. IV (R45)
8-9	29	19	30	29
6-7	01	11	-	01
3-5	-	-	-	-
0-2	-	-	-	-
Mean ±SD	8.93 ± 0.36	7.73* ± 1.2	8.83 ±0.38	8.77 ±0.5

➢ The mean intubation score is maximum in group I (sch) that is in suxamethonium group. It is comparable with that of group III arid group IV ($p>0.05$)

➢ The mean intubation score in group II (TR60) differs significantly from group I (sch), group III (R60) and group IV (R45)($p<0.001$).

Table No. 4 showing grading and acceptability

Grading	Gr.I(SCH)	Gr.H(TR60)	Gr.III(R60)	Gr.IV(R45)
Excellent	29/30(96.7%)	19/30(63.3%)***	30/30(100%)	29/30(96.7%)
Good	1/30(3.3%)	11/30(36.6%)	-	1/30(3.3%)
Fair	-	-	-	
Poor	-	-	-	-

*** $p<0.001$ Highly significant Excellent and Good: Acceptable

Fair and Poor: Unacceptable

➢ Acceptable intubating conditions were observed in all the patients studied. Intubating conditions in group I (Sch) and group IV (R45) were found to be similar with 96.7% patients in both the group showing excellent intubating conditions. While all the patients in group III (R60) showed excellent intubating conditions. Intubating conditions were comparable in group I (Sch), group III (R60) and group IV (R45).

➢ In group II (TR60) only 63.3 %(19/30) showed excellent intubating conditions and 36.6 % (11/30) showed good intubating conditions; as timing principle was not followed in this group.

Table No. 5 showing side effects and complications

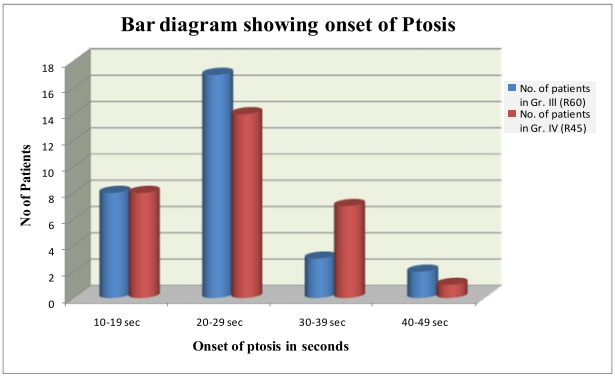
Complication	Gr.I(Sch)	Gr.II(TR60)	Gr.HI(R60)	Gr.IY(R45)
Adverse drug reactions	-	-	-	-
Rash	-	01	-	02
Pruritus	-	-	-	-
Broncospasm	-	-	-	-
Inj site oedema	-	-	01	-
Bradycardia	02	-	-	-
Dysrrythmias	-		-	-

➢ Rash was observed in one patient in group II (TR60) and two patients in group IV (R45).

➢ Injection site oedema was observed in one patient in group III (R60).

➢ Bradycardia was observed in two patients in group I(sch).

FIGURE



DISCUSSION

The goal of tracheal intubation is to secure the patients airway quickly and smoothly with minimum chances of hypoxia or regurgitation and aspiration of gastric contents. Traditionally suxamethonium has long been the muscle relaxant of choice for facilitation of laryngoscopy and intubation, because of its fast onset and short duration of action. However it falls short of qualities of 'ideal' muscle relaxant due to its side effects like, dysrrythmias, bradycardia, increased intragastric and intraocular pressure, hyperkalemia, malignant hyperthermia etc.

To avoid side effects of depolarizing muscle relaxant nondepolarising muscle relaxant like pancuronium, vecuronium and atracuronium are used for intubation, but onset time is too long, of about 2-4 min with these nondepolarising drugs.

In early 1990's, the new nondepolarising muscle relaxant, rocuronium with its rapid onset of action; comparable with suxamethonium was introduced. The efficacy of rocuronium for rapid trachal intubation has been studied by many. [5, 3, 6]

Considering the favourable reports of rocuronium over other non-depolarising muscle relaxant with respect to its fast onset which is comparable with suxamethonium, we decided to use rocuronium for endotracheal intubation.

When this technique is used, a single bolus dose of a muscle relaxant is administered, and anaesthesia is induced at the onset of clinical weakness. In this way, the time from the induction of anaesthesia to complete muscle relaxation is reduced, and the peak effect of muscle relaxant and IV induction drug may coincide more closely.

Timing of Intubation:

Cooper R et al found that the degree of block present after rocuronium 0.6 mg/kg was about 89% and 98% at 60 sec and 90 sec respectively [1].

Previous studies have shown that complete block of adductor pollucis muscle is not required for the provision of good intubating conditions. [7, 8, 9]

The good intubating conditions provided by rocuronium 0.6mg/kg at 60-90 sec are because of greater speed of onset of rocuronium action. Another reason could be the earlier occurrence of block in the vocal cords with rocuronium, in contrast with onset of block in adductor pollucis muscle. [10]

I n most studies, appropriate timing of tracheal intubation has been determined by three ways -

> Clinical judgement

> Neuromuscular monitoring either by twitch suppression (maximum blockade) or TOF ratio

> Predetermined time after the administration of neuromuscular blocking agent E.g. 60 sec, 90 sec, 120 sec etc.

The technique using clinical judgement alone is relatively insensitive. Onset time differs with different nerve stimulation rates used. Cooper et al found onset time with rocuronium 0.6 mg/kg as 90 sec by 0.1 Hz stimulation and 58 sec using TOF stimulation [1]. Alternatively, a predetermined time for tracheal intubation can be used.

Hence in this study, laryngoscopy and tracheal intubation was attempted after 60sec. Along with this, it was tried to investigate whether tracheal intubation can be accomplished after 45 sec using timing principle as in group IV (R45) laryngoscopy and tracheal intubation was attempted 45 sec after end point of induction.

Onset of Ptosis:

In this study onset of ptosis was considered as an indication of clinical weakness.

Donati F et al found that the onset time of neuromuscular blockade was longer at the adductor pollucis than at the diaphragm and the orbicularis oculi blockade may be good guide to diaphragmatic blockade [11].

Kwong Fah Koh et al postulated that the onset time of non-depolarizing neuromuscular blockade in the levator palpebrae is comparable with that of orbicularis oculi. So that ptosis developed together with diaphragmatic paralysis leading to more cooperative patients in their study [12].

In the present study onset time of ptosis was ranged between 10 to 45 sec. The mean onset time of ptosis was 22.66 ± 8.04 in group III and 23.1 ± 7.77 sec in group IV. (Refer table no.1)

The mean onset time of ptosis was comparable in both the groups ($p>0.05$).

As the induction was done before the administration of relaxant in group I (Sch) and group II (TR60), ptosis was not observed in these groups.

Sieber T J et al found that mean onset time of clinical weakness with rocuronium was 32 ± 4.9 sec [13].

Scoring and Grading of Intubating Conditions:

In this study the mean intubation score was found to be 8.93 (± 0.36) in group I (Sch), 7.73 (± 1.2) in group II (TR60), 8.83 (± 0.38) in group III (R60) and 8.77(± 0.5) in group IV (R45) (Refer table no.4).

The mean intubation score was maximum in group I (Sch) that is in suxamethonium group. The mean intubation score was lesser in group II (TR60) in which timing principle was not followed than group III (R60) and group IV (R45) in which timing principle was followed.

The mean intubation score in group II (TR60) differs significantly from group I (Sch), while mean intubation score in group I (sch), group III (R60) and group IV (R45) were comparable as they were statistically insignificant ($p>0.05$).

In this study acceptable intubating were observed in all the patients studied. Intubating conditions in group I (Sch) and group IV (R45) were found to be similar with 96.7% patients (29/30) patients in both the groups showing excellent intubating conditions (Refer table no. 3 and 4)

This suggests that, even if intubation is attempted earlier that is at 45 sec, using timing principle, acceptable intubating ny of the study patients.

conditions are achieved. So the drug can further be used in rapid sequence intubation technique also [14, 15]

. While all the patients in group III (R60) showed excellent intubating conditions. Intubating conditions were comparable in group I (sch) group III (R60) and group IV (R45) ($p>0.05$).

The intubating conditions obtained by using timing principle are at par with suxamethonium, suggesting rocuronium can be an alternative to suxamethonium.

In group II (TR60) only 63.3% (19/30) showed excellent intubating conditions, while 36.6% (11/30) patients showed good intubating conditions as timing principle was not followed in this group.

In group IV mean apnoea onset time was 43.57(± 8.21) sec while laryngoscopy and intubation was attempted 45 sec after end point of induction. Hence excellent intubating conditions were found in as many as 29 patients and good intubating condition in one patient.

Sieber TJ et al observed intubating conditions as excellent in 66.6% (10 out of 15) patients after administration of rocuronium 0.6 mg/kg using the 'timing principle' at 45 and 60 sec and good intubating conditions in 33.3 % patients [13].

Fuchs-Buder and Tassonyi et al determined that intubating conditions were good to excellent in all patients investigated under balanced anaesthesia. With rocuronium 0.6 mg/kg dose, excellent conditions were found in 82% patients and good conditions in 17% patients [16].

Huizinga ACT et al found that all patients receiving rocuronium 0.6 mg/kg could be intubated under good (1 out of 10) or excellent (9 out of 10) conditions and no difference in intubating conditions were found between intubating after 60 sec or 90 sec after administration of rocuronium. Intubating conditions are comparable to suxamethonium [2].

Mccourt KC et al found that rocuronium 1.0 mg/kg and suxamethonium 1.0 mg/kg showed no significance difference in the incidence of acceptable intubations (96% and 97% respectively). The incidence of excellent grade of intubations was however significantly higher with suxamethonium (80% versus 65%) [5].

Puhringer FK et al found that proportion of the patients with excellent (8 versus 17) or good (1 versus 3) intubating conditions were not different ($p<0.34$) for rocuronium 0.6 mg/kg and suxamethonium 1.0 mg/kg at 60 sec [3].

Thus the results of intubating conditions of rocuronium 0.6 mg/kg in the present study are comparable with the various other studies mentioned above.

Side effects

These can be related to drug used in the study; complications can be related to technique of or schedule of drug administrations.

In the present study rash along the vein of injection was observed in one patient in group II (TR60) and two patients in group IV (R45). Rash was self limiting.

Rash was not associated with other evidence of histamine release and could not be definitely ascribed to the use of rocuronium. In clinical studies only a slight increase in mean plasma histamine levels has been observed following bolus administration of 0.3-0.9 mg/kg rocuronium.

Injection site oedema was observed in one patient in group III (R60). Bradycardia was observed in two patients in group I (Sch).

CONCLUSIONS

Rocuronium bromide, a new steroidal non-depolarising muscle relaxant of intermediate duration and cardiovascular stability, provide remarkably excellent intubating conditions comparable to suxamethonium. It can be considered as an alternative to suxamethonium even if rapid sequence intubation is required.

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