

TRACHEAL INTUBATION WITH ROCURONIUM

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Intubation of the trachea is an important procedure, allowing maintenance and protection of the airway and reliable ventilation of the lungs during anaesthesia and surgery and in the Intensive Care Unit. Although intubation can be carried out without the use of muscle relaxants, use of neuromuscular blocking drugs allows intubation to be performed at lighter planes of anaesthesia, and has become standard practice.

NEED FOR A RAPID ACTING NON-DEPOLARIZING RELAXANT

Although intubation in elective situations can be facilitated rapidly with the use of suxamethonium, its use is associated with many side effects, some of which can have serious consequences. It has therefore become routine to use a non-depolarizing relaxant for facilitation of both intubation and maintenance of relaxation for elective surgery. The need for a non-depolarizing relaxant with a rapid onset of effect was highlighted by Saverese and Kitz nearly twenty years back¹. Atracurium and vecuronium are not rapid acting enough to allow intubation within 60 s, as can be achieved with suxamethonium, unless they are used in large doses.

The introduction of the new aminosteroid relaxant rocuronium bromide has now provided anaesthetists with a non-depolarizing relaxant with a rapid onset of effect when used in a conventional 2x ED₉₅ dose (0.6 mg/kg). A rapid acting agent helps to keep the interval between loss of consciousness and the control of airway short, thus minimising the risk of complications such as aspiration which may be associated with bag and mask ventilation. In addition, rapid sequence induction of anaesthesia necessitates the use of a rapid acting relaxant.

Before describing the use of rocuronium for intubation, it is worthwhile looking at the method of evaluation of intubating conditions and also to examine the use of relaxant-free techniques for tracheal intubation.

ASSESSMENT OF INTUBATION

The process of intubation involves opening the

mouth, visualizing the larynx and the vocal cords and placing the tube in the trachea. This process is facilitated by good jaw relaxation, and abducted and immobile vocal cords. Hence these variables along with the actual overall response to intubation in the form of coughing or bucking are important in the assessment of intubating conditions. One of the earlier schemes for assessment of intubating conditions was described by Lund and Stoner². Their assessment was based on these variables which were combined to describe the overall intubating conditions as excellent, good, and fair, and an 'implied' impossible. A modification of this scheme using a four-point scale was described in the 1980's for assessing intubating conditions with vecuronium and atracurium^{3,4}. There are other schemes also but these are all based on evaluation of the same variables.

Some new standards for ensuring uniformity have been put forward at the recent Copenhagen Consensus Conference⁵. These include the assessor being blinded, using suxamethonium as the standard comparator, standardising the time of intubation, avoiding giving numeric scores, and classifying the intubating conditions into three categories of excellent, good, and poor for the overall assessment.

INTUBATION WITHOUT MUSCLE RELAXANTS

The skill of the anaesthetist and the depth of anaesthesia have considerable influence on intubating conditions. The availability of propofol and the observation that it causes greater suppression of laryngeal reflexes has renewed interest in intubation without relaxants. Intubating conditions attained using propofol 2.5 mg/kg alone are however, far from ideal and have been considered acceptable in only about half the patients^{6,7}. Addition of alfentanil and/or lignocaine makes intubating conditions somewhat more acceptable⁸⁻¹⁰. However persistent coughing, significant movement and a low incidence of truly excellent or good grade intubations are common features in these and other reports with coughing or movement in a significant number of patients^{11,12}. Hence while intubation without relaxants may have a

place in elective surgery in fasting patients in whom the quality of intubation conditions is not crucial, the matter does not offer reliably good intubating conditions.

INTUBATION WITH 2X ED₉₅ (0.6 MG/KG) DOSE ROCURONIUM

The earliest studies of intubating conditions with Rocuronium were published in 1992. Puhlinger et al compared intubating conditions 60 s after rocuronium 0.6 mg / kg and suxamethonium 1 mg / kg during anesthesia with alfentanil 25 µg/kg, nitrous oxide in oxygen and a propofol infusion¹³. They observed no difference in the intubating conditions between suxamethonium and rocuronium, the conditions being excellent in 17 out of 20 patients receiving rocuronium and in 8 out of 10 receiving suxamethonium.

Intubating conditions following rocuronium 0.6 mg / kg or suxamethonium 1.5 mg / kg (pre-treated with galamine 10 mg) and a group receiving no relaxant following anesthesia with alfentanil 1 mg and propofol 1.5-2.5 mg / kg have been reported by Huizinga et al.¹⁴. They showed the intubating conditions at 60 or 90s to be similar following rocuronium and suxamethonium being excellent or good in all patients. Half of the control patients receiving no relaxant could not be intubated.

Cooper et al. examined the intubating conditions at 60 or 90 s with 0.6 mg / kg rocuronium or 1.0 mg / kg suxamethonium during anesthesia with thiopentone, fentanyl and nitrous oxide in oxygen¹⁵. They observed no significant differences between suxamethonium and rocuronium; however the quality of intubations, particularly at 60 s, tended to be excellent more often following suxamethonium.

The intubating conditions following rocuronium are better than with equipotent doses of vecuronium or mivacurium when assessed at 90s¹⁶.

It is now generally well established that excellent to good intubating conditions with rocuronium prevail even when neuromuscular block at the adductor pollicis muscle is not complete. This is due to the occurrence of block at the laryngeal muscles at an earlier time than at the adductor pollicis although laryngeal muscles appear to be more resistant^{17,18}. Administration of a twice the ED₉₅ dose ensures that adequate block occurs at the laryngeal muscles.

INTUBATION WITH HIGH DOSE (0.9 MG / KG) ROCURONIUM

Although intubating conditions following 0.6 mg / kg of rocuronium are generally acceptable at 60 s, these

are not always of an excellent grade. While this is acceptable in most situations, the conditions may not be acceptable in patients with raised intracranial or raised intraocular pressure. In such situations the use of a 0.9 mg / kg dose may be more appropriate.

Maddineni et al. observed the intubating conditions to be excellent in everyone in a small group of 10 patients using a 0.9 mg / kg dose of rocuronium¹⁹.

Crul et al. have recently assessed the intubating conditions using alfentanil 20 µg / kg and propofol 2.0-2.5 mg / kg, 45 or 60 s following 0.6 or 0.9 mg / kg of rocuronium²⁰. The dose of rocuronium made a significant difference to the conditions, with 36 out of 40 intubations in the 0.9 mg / kg group being graded excellent, compared to only 22 out of 40 in the 0.6 mg / kg group, the conditions being classified as good in the remainder.

INTUBATION WITH LOW DOSE ROCURONIUM

As rocuronium has an intermediate duration of action, using a dose of 2x ED₉₅ for short surgical procedures may result in a relatively long duration of clinical relaxation.

Prien et al have reported intubating conditions using 0.3 mg / kg rocuronium during anesthesia with 20 µg/kg alfentanil and an infusion of propofol and nitrous oxide, or 3.0 mg / kg fentanyl, 4-6 mg / kg thiopentone and 1 MAC of enflurane²¹. Intubation was performed 5 mm after induction of anesthesia and when maximum block (98-100%) had supervened. The intubating conditions were described as excellent or good in about 90% of patients within 65 and 69s in the two groups respectively; the frequency of excellent grade being slightly higher in the propofol group. It is surprising that all patients attained a block 98% or greater with a dose of 1x ED₉₅. It is also likely that acceptable intubating conditions were obtained because of relatively deeper anesthesia. The total recovery time, as expected with this, dose of rocuronium, was 25-30 mm.

In another study the intubating conditions were described as excellent or good within 60 s in 80% of patients receiving a dose of 0.45 mg / kg of rocuronium during anesthesia with propofol, fentanyl and isoflurane²². The conditions following equipotent doses of atracurium and vecuronium were similar in only 12.5% of patients. The clinical duration of this dose of rocuronium was reported by these authors to be 22 min.

Studies with low dose rocuronium would indicate that while intubation is possible within 60 s with doses

of 0.3-0.45 mg / kg the conditions are perhaps not always excellent and a time of about 90-120 s may be more appropriate to achieve good conditions. The depth of anesthesia also requires being greater. The advantage of such doses is a relatively short duration of action.

A summary of the main findings of intubation studies with rocuronium is given in Table I.

Table 1. Summary of intubating conditions with rocuronium.						
Dose (mg kg ⁻¹)	Time of intubation	No. of patients	Grade of intubation (%)			
			Excellent	Good	Fair	Poor
0.6	60 s	20	65	30	5	-
0.6	90 s	20	85	15	-	-
0.6	60 s	20	85	15	-	-
0.6	60 s	10	90	10	-	-
0.6	90 s	10	90	10	-	-
0.6	45 s	20	60	40	-	-
0.9	45 s	19	89	11	-	-
0.9	60 s	10	100	-	-	-
0.3	65 s*	20	40	50	-	-
0.45	60 s	15	60	20	20	10

* Average time for intubation; intubation graded on a 3 point scale

ROCURONIUM AND THE 'PRIMING' TECHNIQUE.

Several years back Foldes suggested that muscle relaxants given in divided doses would be associated with a more rapid onset of block than when the same dose is given as a single bolus and this was demonstrated by a study published by that group^{23,24}. There have been studies published since then but with conflicting results.

Although intubating conditions in many studies comparing rocuronium and suxamethonium have been similar, it is generally agreed that the time to maximum block of 0.6 mg / kg dose of rocuronium is slower than that of suxamethonium 1 mg / kg. The technique of priming has therefore also been tried with rocuronium in an attempt to accelerate its onset of block further and obtain more uniformly excellent intubating conditions with it.

Hofmockel and Benad have compared the intubating conditions following 0.6 mg / kg of rocuronium given as a single dose or 0.06 mg / Kg followed by a dose of 0.24 mg / kg 4 min later (a total of 2x and 1x ED95 doses respectively)²⁵. Anesthesia was with propofol, alfentanil and nitrous oxide in oxygen and intubation was carried out at development of 90% block. These workers observed that the intubation time was significantly shorter

(40 s) in the 0.6 mg / Kg group compared to the group receiving the divided doses (50 s) but that the intubating conditions at these times were similar, being good or excellent in all cases (n= total of 30). They also noticed that 60% of patients receiving this priming dose developed partial block. As their patients were anesthetized before receiving the priming dose, it was not possible to determine how many would have subjectively felt the muscle weakness. The clinical duration of action after the two doses was 15 min and 28 min for the 1x ED95 and 2x ED dose, respectively. -

Priming of rocuronium with a prior dose of rocuronium itself or mivacurium has been described by Naguib²⁶. He observed that when mivacurium 0.015 mg / kg or rocuronium 0.06 mg / kg were administered before rocuronium 0.54 mg / kg, the onset of action of the main dose of rocuronium was faster (average of 90 and 73 s, respectively) than the onset of action of a single 0.6 mg / kg dose of rocuronium. However, the intubating conditions did not differ between the groups suggesting the lack of usefulness of the priming technique with rocuronium. Foldes et al. had previously been unable to show any benefit by using the priming technique with rocuronium²⁷.

One of the main disadvantages of the technique of priming is the occurrence of significant muscle weakness with the priming doses, which are useful in producing better intubating conditions²⁸. Due to an inherently rapid onset of effect of rocuronium, it is likely that the benefits of using the priming technique with it will be substantially less. The rapid onset may also lead to a greater likelihood of muscle weakness being perceived by the patient due to occurrence of partial block with the priming doses^{21,25}. Priming may also be associated with other side effects such as pulmonary aspiration²⁹.

ROCURONIUM AND RAPID SEQUENCE INDUCTION

The aim of a "rapid sequence induction" is to secure the airway as soon as possible after loss of consciousness but without ventilating the lungs so that the chances of regurgitation are minimized. Such a technique is indicated in emergency situations and in the presence of a full stomach. The technique consists of preoxygenation and administration of a rapid acting intravenous induction agent followed by a rapid acting relaxant. Intubation is usually carried out 45-60 s later. Suxamethonium has been the muscle relaxant used because of its rapid onset of action. Its use can however be associated with many side effects. The rapid onset of action of rocuronium and the similarity of its intubating conditions with those of suxamethonium

would suggest the possibility of using rocuronium as part of a rapid sequence induction.

The use of rocuronium in rapid sequence induction was first described by Magorian et al. Who compared intubation conditions after 0.6, 0.9, or 1.2 mg / kg of rocuronium, 1 mg / kg suxamethonium and 0.1 mg / kg vecuronium in groups of 10 patients each³⁰. Tracheal intubation was carried out 60 s after the relaxant administration. They observed no significant differences in the intubating conditions between the groups, being excellent in all 10 patients even in those receiving rocuronium 0.6 mg / kg. Once again, neuromuscular measurements showed that intubation was frequently satisfactory despite incomplete neuromuscular block at the adductor pollicis muscle. The authors however, concluded that "only 0.9 or 1.2 mg / kg of rocuronium were comparable to suxamethonium" based on the onset times rather than the intubating conditions. Although described as a "rapid sequence induction", patients remained anesthetized for about 10 min before receiving the relaxant, were hand-ventilated during this time and no cricoid pressure was applied.

Tryba et al. have reported a preliminary study in which premedicated patients for elective surgery were anesthetized with fentanyl 2 µg / kg followed by thiopentone 6 µg/kg³¹. Muscle relaxation was with suxamethonium 1.5 mg / kg (preceded by rocuronium 0.04 mg / kg), or with rocuronium in a total dose of 0.6 mg / kg, given either immediately before or immediately after induction, or in divided doses before and after induction of anesthesia. A rapid sequence induction was used, and intubation carried out within 60 s. Rocuronium was found to provide better intubating conditions when given before the induction of anesthesia, but no advantage was seen in dividing the dose (priming). Intubating conditions with rocuronium given before the induction agent were comparable to those with suxamethonium, but were not as good when rocuronium was given after thiopentone.

Sparr et al. (H Sparr, personal communication) have recently carried out a study comparing 1.0 mg / kg of suxamethonium and 0.6 mg / kg of rocuronium in a simulated rapid sequence induction in patients undergoing elective surgery. The intubating conditions were assessed by an observer blinded to the given relaxant. While the incidence of clinically acceptable intubations was not significantly different between the groups, the conditions were graded as excellent significantly less often in those receiving rocuronium. Their suggestion is that the dose of rocuronium would need to be greater than 0.6 mg / kg, perhaps in the region of 0.9-1.0 mg / kg, for attaining uniformly good intubations. This view

was also expressed by Crul et al.²⁰.

There is only one study reported in a small number of patients examining the use of rocuronium in "real" emergency cases³². In this study the authors carried out a conventional rapid sequence induction using 0.6 or 0.9 mg / kg of rocuronium or 1.5 mg / kg of suxamethonium. The intubating conditions were excellent in 7/7 patients with suxamethonium, in 7/8 with rocuronium 0.9 mg / Kg, and in 4/7 patients with rocuronium 0.6 mg / Kg.

Another study in which rocuronium 0.6 mg / kg was used to facilitate intubation in patients for elective caesarean section, has also been reported³³. Intubating conditions were reported as excellent or good in 36 out of 40 patients but only if the dose of thiopentone was 5-6 mg / kg but were not acceptable if the dose of thiopentone was 4 mg / kg or less. A comparative group receiving suxamethonium was not included. More studies with rocuronium in larger numbers of patients are therefore still necessary, including those cases, which truly require a rapid sequence induction. Two large scale multi-centre studies are currently in progress examining the use of rocuronium as part of a rapid sequence induction.

Muscle relaxants may have a role in reducing the complications associated with intubation in emergencies³⁴. If this role for relaxants is established, rocuronium out of the currently used agents would have a role in that situation.

CONCLUSION

Rocuronium (Esmeron or Zemuron) is a rapid acting nondepolarizing relaxant drug which can be used to facilitate early intubation.

It may be a suitable alternative to suxamethonium in a dose of 0.6-0.9 mg / kg for use during a rapid sequence induction. It must however be remembered that its duration of action is similar to that of atracurium and vecuronium and therefore any difficulties with intubation must be ruled out before contemplating its use.

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