Intubating conditions and neuromuscular block after divided dose mivacurium or single dose rocuronium

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Purpose: To evaluate the tracheal intubating conditions and neuromuscular blocking characteristics of divided dose mivacurium or single dose rocuronium.

Methods: Thirty-two patients undergoing elective surgery were studied. Anaesthesia was with propofol 2 $mg \cdot kg^{-1}$, followed by an infusion of 150 $\mu g \cdot kg^{-1} \cdot min^{-1}$. Patients were randomized to receive either mivacurium- 0.15 $mg \cdot kg^{-1}$ followed 30 sec later by 0.1 $mg \cdot kg^{-1}$, or rocuronium- 0.9 $mg \cdot kg^{-1}$, followed 30 sec later by placebo. Tracheal intubating conditions were assessed 90 sec after the initial dose of relaxant by an anaesthetist who was unaware of patient group. The electromyographic (EMG) response of the first dorsal interosseus muscle to ulnar nerve train-of-four was measured.

Results: Successful tracheal intubation was performed in all patients after both mivacurium and rocuronium. Intubating conditions (jaw relaxation, open visible vocal cords) were judged to be good-excellent in all but one patient before insertion of the tracheal tube. However, patients receiving mivacurium were more likely to experience coughing and bucking after tracheal tube insertion (10/16 patients) than those receiving rocuronium (3/16 patients, $P < 0.05$). No patient in the rocuronium group experienced moderately vigorous coughing and bucking after insertion of the tracheal tube *vs* six patients in the mivacurium group ($P < 0.05$). Time to 10 and 25% recovery of neuromuscular function was faster ($P < 0.05$) after divided dose mivacurium (20 ± 1 and 23 ± 1 min, respectively) than after rocuronium (45 ± 5 and 57 ± 8 min, respectively).

Conclusion: The results suggest that, during conditions of the study, divided dose mivacurium is not recommended for a 90-sec tracheal intubation in patients where moderate coughing and bucking is deemed unacceptable.

Objectif : Évaluer les conditions de l'intubation de la trachée et les caractéristiques du bloc neuromusculaire au mivacurium à dose fractionnée et au rocuronium à dose unique.

Méthodes : Cette étude réunissait 22 patients programmés pour une chirurgie non urgente. L'anesthésie était réalisée avec du propofol 2 $mg \cdot kg^{-1}$, suivi d'une perfusion de 150 $\mu g \cdot kg^{-1} \cdot min^{-1}$. Les patients recevaient aléatoirement soit du mivacurium 0,15 $mg \cdot kg^{-1}$ suivi 30 sec plus tard par 0,1 $mg \cdot kg^{-1}$, soit du rocuronium 0,9 $mg \cdot kg^{-1}$, suivi 30 sec plus tard d'un placebo. Les conditions d'intubation de la trachée étaient évaluées 90 sec après la dose initiale de myorelaxant par un anesthésiste ignorant le groupe auquel le patient appartenait. La réponse électromyographique (EMG) à la stimulation au train-de-quatre (TOF) du premier muscle interosseux dorsal était mesurée.

Résultats : L'intubation de la trachée a été réussie chez tous les patients des deux groupes. Les conditions d'intubation (relaxation de la mâchoire, visualisation de cordes vocales béantes) avant l'insertion de la canule trachéale étaient jugées de bonnes à excellentes chez tous les patients à l'exception d'un seul. Cependant, les patients sous mivacurium étaient plus sujets à la toux et au cabrage après l'insertion de la canule (10/16 patients) que ceux qui avaient reçu le rocuronium. (3/16 patients, $P<0,05$). Aucun des patients du groupe rocuronium n'a présenté de toux et de cabrage notoires après l'insertion de la canule comparativement à six patients du groupe mivacurium ($P<0,05$). Le temps de récupération à 10% et 25% de la fonction neuromusculaire était plus rapide ($P<0,05$) après le mivacurium à dose fractionnée (respectivement 20±1min et 23±1 min) qu'après le rocuronium (respectivement 45±5 et 57±8 min).

Conclusion : Ces résultats suggèrent que dans les conditions de l'étude, le mivacurium à dose fractionnée n'est pas recommandé après 90 sec pour une intubation de la trachée chez des patients chez qui une toux ou un cabrage d'intensité modérée sont jugés inacceptables.

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Supported by the MetroHealth Foundation (N. Kamath). Presented in part at the Canadian Anaesthetists Society Annual Meeting, June, 1995 and the Ohio Society of Anesthesiologists Annual Meeting, September 9, 1995.

Burroughs Wellcome Inc. donated the mivacurium, and Organon Inc. donated the rocuronium.

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Accepted for publication September 7, 1996.

ROCURONIUM is a nondepolarizing, steroidal muscle relaxant with an ED_{95} of 0.3 $mg \cdot kg^{-1}$, intermediate duration of action, no histamine release, and a rapid onset time.[1,2] The rapid onset associated with rocuronium has been attributed to this drug's lower potency,[3] which may allow more molecules to access the effector sites during the first few circulation times. Mivacurium is a nondepolarizing relaxant of the benzylisoquinoline type, with an ED_{95} of 0.06 $mg \cdot kg^{-1}$, short duration of action and mild histamine releasing properties.[4] The short duration of mivacurium is due to rapid hydrolysis by plasma cholinesterase.[4]

Good to excellent tracheal intubating conditions have been reported within 60 sec following rocuronium, 0.6–1.2 $mg \cdot kg^{-1}$ (2–4 × ED_{95}),[2] and within 120 sec following mivacurium, 0.15– 0.20 $mg \cdot kg^{-1}$ (2–2.5 × ED_{95}), in anaesthetized patients.[5,6] Recently, Ali *et al.* have shown that divided dose mivacurium, 0.15 followed by 0.1 $mg \cdot kg^{-1}$, compared favourably with succinylcholine 1.5 $mg \cdot kg^{-1}$ preceded by d-tubocurarine, 0.05 $g \cdot kg^{-1}$ in terms of tracheal intubating conditions.[7] Using this mivacurium intubating paradigm, they reported successful tracheal intubation 90 sec after the initial dose of mivacurium in 24/25 patients, with an intubating score of good or excellent in 23/25 patients.[7] There was, however, a 43% incidence of coughing after insertion of the endotracheal tube.[7] The purpose of this randomized, double blind study was to compare the tracheal intubating conditions and neuromuscular blocking characteristics associated with divided dose mivacurium and single dose rocuronium in anaesthetized patients.

Methods

The protocol was approved by the Institutional Review Board. All patients gave written informed consent. Thirty-two adult ASA physical status I–III patients undergoing elective surgery requiring general anaesthesia, tracheal intubation, and neuromuscular blockade were randomly assigned to receive mivacurium or rocuronium. Randomization was with a table of random numbers. Exclusion criteria were suspected difficulty with mask ventilation (i.e., obesity, thick beard, massive jaw, facial burns/grafts) or difficult direct laryngoscopy (i.e., disproportionately increased size of base of tongue relative to pharynx size, decreased mandibular space, and decreased extent and mobility of airway joints). Additional exclusion criteria were therapy with drugs known to interfere with neuromuscular transmission, liver disease, renal disease, and plasma cholinesterase deficiency. No premedication was used. Monitors consisted of ECG, noninvasive blood pressure cuff, pulse oximeter, end-tidal CO_2, oesophageal stethoscope, and temperature. Anaesthesia was induced with 1–2 mg midazolam, 50–100 μg fentanyl, 20 mg lidocaine, and 2 $mg \cdot kg^{-1}$ propofol, and maintained with 150 $\mu g \cdot kg^{-1} \cdot min^{-1}$ propofol prior to intubation. The patients' lungs were ventilated with 100% O_2 to maintain end- tidal CO_2 between 30–35 mmHg. Anaesthesia was maintained with isoflurane and N_2O after intubation.

The hand, wrist and forearm were immobilized in a splint. Following induction of anaesthesia, the evoked compound electromyographic (EMG) response of the first dorsal interosseus muscle to ulnar nerve train-of-four (TOF) supramaximal stimulation was evaluated at 10 sec intervals with the Relaxograph Monitor (Model NMT-100, Datex Instrumentarium Corp., Helsinki, Finland). The EMG amplitude was measured three milliseconds after the stimulation pulse, and the measuring window width was 15 msec. After a stable EMG response was obtained, patients in the mivacurium group received divided doses of this agent, 0.15 $mg \cdot kg^{-1}$, followed by 0.1 $mg \cdot kg^{-1}$, 30 sec later (total dose approximately 3 × ED_{95}). Patients in the rocuronium group received a single 3 × ED_{95} dose of this drug, 0.9 $mg \cdot kg^{-1}$, followed by 0.9% saline (placebo). Study relaxants were prepared and injected into a free running IV by a physician not involved in grading laryngoscopy and intubation. Direct laryngoscopy by an experienced intubator, unaware of the TOF response or of the relaxant, was started 90 sec after the initial dose of relaxant. Orotracheal intubation was performed immediately after visualization of the vocal cords. A# 3 or #4 Macintosh laryngoscope blade was used. A cuffed 7.0 mm I.D. tracheal tube was used in female patients and a cuffed 8.0 mm I.D. in males (Mallinckrodt Medical Inc, St Louis, MO). Intubating conditions were graded using standardized criteria.[8] Jaw relaxation prior to laryngoscopy was classified as excellent if the jaw was completely mobile, good if the jaw was partly mobile, or poor if the jaw was immobile. Vocal cords at intubation were classified as visible and open, visible but moving, visible but closed, or not visible. Presence of coughing, bucking, or movement after insertion of the tracheal tube was evaluated as none, mild- 1 or 2 weak coughs, moderate- > 2 coughs and moderately vigorous coughing and bucking, or severe- purposeful movement, very vigorous coughing and bucking. Duration of intubation and number of intubation attempts were recorded.

The following data were measured: maximal first EMG (T_1) depression (T_1/control × 100) achieved after relaxant administration, time to achieve 80% and maximal depression of T_1, T_1 90 sec after the initial dose of

relaxant, and time to 10%, 25% and 75% spontaneous recovery of T_1. Blood pressure and heart rate were recorded at baseline prior to induction of anaesthesia, 5 and 10 min after intubation, and at the end of surgery.

Data are reported as mean values ± standard errors of the mean (SEM). Demographic and neuromuscular data were compared between groups using Student's t test. Haemodynamic data were compared using analysis of variance with Tukey's test. Intubating conditions were compared using the Cochran- Mantel- Haenszel statistic. A P value < 0.05 was considered significant.

Results

The groups were similar in age, weight, height, duration of surgery and time spent in the recovery room (Table I). There were more women in the mivacurium than in the rocuronium group (Table 1). There were no differences in blood pressure or heart rate between groups (Table II). All patients were classified as Mallampati class I and there were no difficulties in visualizing the vocal cords in any patient. All tracheas were successfully intubated on the first attempt within 15 sec of beginning direct laryngoscopy. The T_1 at intubation was 52 ± 5% with mivacurium and 8 ± 3% with rocuronium ($P < 0.05$). Although all patients developed 100% neuromuscular blockade, compared with divided dose mivacurium, rocuronium, 0.9 mg·kg^{-1}, was associated with faster times to 80% and 100% T_1 block ($P < 0.05$, Table III). Compared with rocuronium, patients receiving mivacurium were more likely to experience moderate coughing and bucking after tracheal tube insertion, $P < 0.05$, Table IV). Spontaneous recovery to 10% and 25% T_1 was longer after rocuronium than after mivacurium ($P < 0.05$, Table III). Five patients (31%) in the mivacurium group required reversal of neuromuscular blockade compared with 13 patients (81%) in the rocuronium group ($P < 0.05$). Three patients in the mivacurium group (two of whom had no reversal agents) and one patient in the rocuronium group required treatment for post- operative vomiting.

TABLE I Demographic data in patients receiving divided dose mivacurium, total dose 0.25 mg·kg^{-1}, or single dose rocuronium, 0.9 mg·kg^{-1}.

	Mivacurium	*Rocuronium*
Age (yr)	33 ± 2	36 ± 3
Weight (kg)	73 ± 4	72 ± 6
Height (cm)	160 ± 2	169 ± 3
Sex (M/F)	1/15*	4/12
Duration of Surgery (min)	76 ± 15	99 ± 18
Duration of Recovery (min)	113 ± 11	94 ± 10

Mean ± SEM. *$P < 0.05$ *vs* other relaxant

TABLE II Haemodynamic data in patients receiving divided dose mivacurium, total dose 0.25 mg·kg^{-1}, or single dose rocuronium, 0.9 mg·kg^{-1}. Direct laryngoscopy and intubation was 90 sec after the initial dose of relaxant.

	After Intubation			
	Baseline	*5 min*	*10 min*	*End of Surgery*
Systolic Blood Pressure (mmHg)				
Mivacurium	121 ± 5	117 ± 3	105 ± 4	134 ± 5
Rocuronium	126 ± 6	118 ± 5	107 ± 3	132 ± 5
Mean Arterial Pressure (mm Hg)				
Mivacurium	88 ± 4	87 ± 3	79 ± 4	101 ± 3
Rocuronium	95 ± 4	88 ± 4	81 ± 3	103 ± 4
Diastolic Blood Pressure (mmHg)				
Mivacurium	72 ± 4	72 ± 3	65 ± 4	84 ± 3
Rocuronium	80 ± 4	74 ± 4	67 ± 3	88 ± 4
Heart Rate (beats per minute)				
Mivacurium	76 ± 3	93 ± 5	84 ± 4	86 ± 3
Rocuronium	81 ± 3	96 ± 4	94 ± 5	89 ± 4

Mean ± SEM

TABLE III Onset and recovery of neuromuscular block in patients receiving divided dose mivacurium, total dose 0.25 mg·kg^{-1}, or single dose rocuronium, 0.9 mg·kg^{-1}.

	Mivacurium	*Rocuronium*
T_1 at Intubation, %	52 ± 5*	8 ± 3
Time to 80% T_1 block (sec)	116 ±3*	61 ± 6
Time to 100% T_1 block (sec)	183 ± 5*	108 ± 9
Time to 10% recovery T_1 (min)	20 ± 1*	45 ± 5
Time to 25% recovery T_1 (min)	23 ± 1*	57 ± 8
Recovery Index (min)	8 ± 1	17 ± 10

Mean ± SEM. *$P < 0.05$ *vs* other relaxant, Student's t test

TABLE IV Tracheal intubating conditions in patients receiving divided dose mivacurium, total dose 0.25 mg.kg^{-1}, or single dose rocuronium, 0.9 mg.kg^{-1}.

	Mivacurium	*Rocuronium*
Jaw Relaxation		
Excellent, completely mobile	14 (88%)	14 (88%)
Good, partly mobile	1 (6%)	2 (12%)
Poor, immobile	1 (6%)	0
Vocal Cords		
Excellent, visible and open	16 (100%)	16 (100%)
Visible but moving	0	0
Visible but closed	0	0
Cough/Buck response *		
None	6 (37%)	13 (81%)
Slight, 1 or 2 weak coughs	4 (25%)	3 (19%)
Moderate, > 2 coughs, moderately vigorous	6 (37%)	0
Severe, very vigorous response, purposeful movement	0	0

Data are number (%) of patients.

* $P < 0.05$ *vs* other relaxant, Cochran Mantel-Haenszel test.

Discussion

The study demonstrated that successful tracheal intubation could be accomplished in all patients with both divided dose mivacurium and single dose rocuronium. Intubating conditions, as assessed by good jaw relaxation and open visible vocal cords, were judged to be good-excellent in all but one patient prior to insertion of the tracheal tube. However, the use of mivacurium was associated with a 37% incidence of moderate coughing and bucking following intubation and, in one patient (mivacurium group), the jaw was immobile prior to laryngoscopy.

It is recognized that the determination of tracheal intubating conditions is dependent upon the skills and experience of the intubator, the anatomy of the patient, and upon subjective criteria. In the study, an experienced anaesthetist, blinded to the relaxant, assessed the intubating conditions at a predetermined time interval using a standardized scoring system. It is unlikely that bias from different intubators could have accounted for the differences in coughing and bucking after tube insertion observed in the study. This is because the cough buck response represented the most objective of the criteria evaluated. This response was not subtle, but obvious and apparent, and most likely represented incomplete paralysis of the muscles of the diaphragm, larynx, and/or abdominal wall.

The onset time of nondepolarizing muscle relaxants in the central airway musculature of the larynx, jaw and diaphragm is dependent on the presence of a critical number of drug molecules at the neuromuscular junction.[9] When large doses of relaxants are given ($\geq 3 \times ED_{95}$), as in the present study, it is anticipated that optimal intubating conditions develop before loss of TOF response at the hand because neuromuscular blockade in the central airway musculature shows more rapid kinetics and dynamics than in the hand.[10–12]

With divided dose mivacurium, T_1 at intubation was about 50% of control, compared with 8% of control after an equipotent dose of rocuronium. It is possible that the waiting period of 90 sec after the initial dose of mivacurium, or 60 sec after the second dose of mivacurium, was insufficient to allow development of full neuromuscular blockade at the resistant muscles. The 90 sec time interval between initial study drug and laryngoscopy/intubation was chosen because it has been shown for mivacurium that the period of laryngeal paralysis may be as short as two to four minutes, and if one waits for complete block at the hand muscles, neuromuscular block at the larynx may have dissipated. Plaud *et al.* evaluated the onset time and degree of neuromuscular block and the muscles of the adductor pollicis produced by two doses of mivacurium, 0.07 and 0.14 $mg \cdot kg^{-1}$.[13] They found that with both doses of mivacurium, neuromuscular blockade had a faster onset, was less intense and recovered more rapidly at the vocal cords than at the thumb.[13] It should be noted that complete block of the vocal cords did not occur in their study, and that maximum block at the laryngeal adductor muscles developed 133 sec after administration of mivacurium, 0.14 $g \cdot kg^{-1}$.[13] Thus, it is possible that a waiting time of about 130 sec, not 90 sec, is needed to insure optimal block with mivacurium.

Because of the design of the study, a waiting time of 90 sec after the full dose of rocuronium was required prior to laryngoscopy and intubation. It is likely that the onset of good-excellent tracheal intubating conditions associated with this dose of rocuronium occurred earlier than 90 sec, as has previously been demonstrated.[2]

In the present study, TOF monitoring of the muscles of the hand was done. It has been suggested that monitoring of the facial nerve-orbicularis oculis muscle might be a better guide for determining onset of optimal intubating conditions.[14] To test this hypothesis, Sayson and Mongan randomized patients to undergo tracheal intubation at either maximal depression of the orbicularis oculi or at maximal depression of the adductor pollicis after mivacurium, 0.15 $mg \cdot kg^{-1}$.[15] They reported that despite 100% orbicularis oculi blockade, which occurred on average 134 sec after the dose of mivacurium, 7 of 10 patients showed diaphragmatic activity, and one had purposeful movement.[15] Thus, monitoring of the facial nerve-orbicularis oculis muscle may not be particularly useful to predict onset of tracheal intubating conditions following administration of mivacurium.

It has been suggested that an induction dose of propofol, 2.5 $mg \cdot kg^{-1}$, provides adequate conditions for direct laryngoscopy and tracheal intubation, thereby obviating the need for neuromuscular blocking agents. Indeed, Davidson & Gillespie showed that intubating conditions were acceptable in 14/15 patients (93%) receiving propofol, 2.5 $mg \cdot kg^{-1}$, alfentanil, 20 $g \cdot kg^{-1}$, and lidocaine, 1 $mg \cdot kg^{-1}$.[16] However, among these 14 patients, four experienced coughing, two had moving vocal cords, one had closed vocal cords, and two had slight difficulty with laryngoscopy.[16] In a similar study, Mulholland & Carlisle showed that intubating conditions were good- excellent in 20/30 patients (67%) anaesthetized with propofol, 2.5 $mg \cdot kg^{-1}$, and lidocaine, 1.5 $mg \cdot kg^{-1}$, without relaxants.[17] However, in the remaining 10 patients, two had unsatisfactory conditions and eight tracheas were unable to be intubated. Scheller *et al.* administered various doses of alfentanil (30, 40, 50, or

60 $\mu g \cdot kg^{-1}$), followed by propofol 2 $mg \cdot kg^{-1}$ to patients premedicated with midazolam.[8] They found that although tracheal intubation could be accomplished in these patients without the use of relaxants, 30/60 patients had some degree of coughing. Of these 30 patients, five had persistent coughing after intubation and one had purposeful movement.[8] Only with the higher doses of alfentanil, 50–60 $\mu g \cdot kg^{-1}$, were acceptable intubating conditions achieved. Thus, although it is possible to intubate patients' tracheas successfully without the use of relaxants, it is unlikely that the administration of iv anaesthetics can achieve excellent intubating conditions in all patients.

In conclusion, the results of the present study demonstrated that the use of mivacurium is associated with a high incidence of moderate coughing and bucking after intubation – a response that is rarely seen with rocuronium. This movement and moderate coughing and bucking may be particularly undesirable in patients with elevated intracranial or intraocular pressure, and in patients with unstable cervical spines. The study confirmed that duration of action of a $3 \times ED_{95}$ dose of mivacurium was relatively short, with a time to 10% spontaneous T_1 recovery of 19 min, to 25% T_1 recovery of 23 min, and a recovery index of eight minutes. This short recovery time of mivacurium is particularly useful in surgeries where the spontaneous return of neuromuscular function, without the use of reversal agents, is desirable.

Acknowledgment

The authors would like to thank Fran Hall for her secretarial support.

References

1 *Levy JH, Davis GK, Duggan J, Szlam F.* Determination of the hemodynamics and histamine release of rocuronium (ORG 9426) when administered in increased doses under N_2O/O_2 – sufentanil anesthesia. Anesth Analg 1994; 78: 318–21.

2 *Magorian T, Flannery KB, Miller RD.* Comparison of rocuronium, succinylcholine, and vecuronium for rapid-sequence induction of anesthesia in adult patients. Anesthesiology 1993; 79: 913–8.

3 *Law Min JC, Bekavec I, Glavinovic MI, Donati F, Bevan DR.* Iontophoretic study of speed of action of various muscle relaxants. Anesthesiology 1992; 77: 351–6.

4 *Savarese JJ, Ali HH, Basta SJ, et al.* The clinical neuromuscular pharmacology of mivacurium chloride (BW B1090U). A short -acting nondepolarizing ester neuromuscular blocking drug. Anesthesiology 1988; 68: 723–32.

5 *Wrigley SR, Jones RM, Harrop-Griffiths AW, Platt MW.* Mivacurium chloride: a study to evaluate its use during propofol- nitrous oxide anaesthesia. Anaesthesia 1992; 47: 653–7.

6 *Goldhill DR, Whitehead JP, Emmott RS, Griffith AP, Bracey BJ, Flynn PJ.* Neuromuscular and clinical effects of mivacurium chloride in healthy adult patients during nitrous oxide- enflurane anaesthesia. Br J Anaesth 1991; 67: 289–95.

7 *Ali HH, Lien CA, Witkowski T, et al.* Efficacy and safety of divided dose administration of mivacurium for a 90-second tracheal intubation. J Clin Anesth 1996; 8: 276–81.

8 *Scheller MS, Zornow MH, Saidman LJ.* Tracheal intubation without the use of muscle relaxants: a technique using propofol and varying doses of alfentanil. Anesth Analg 1992; 75: 788–93.

9 *Donati F, Meistelman C.* A kinetic-dynamic model to explain the relationship between high potency and slow onset time for neuromuscular blocking drugs. J Pharmacokinet Biopharm 1991; 19: 537–52.

10 *Cantineau JP, Porte F, d'Honneur G, Duvaldestin P.* Neuromuscular effects of rocuronium on the diaphragm and adductor pollicis muscles in anesthetized patients. Anesthesiology 1994; 81: 585–90.

11 *Meistelman C, Plaud B, Donati F.* Rocuronium (ORG 9426) neuromuscular blockade at the adductor muscles of the larynx and adductor pollicis in humans. Can J Anaesth 1992; 39: 665–9.

12 *Wright PMC, Caldwell JE, Miller RD.* Onset and duration of rocuronium and succinylcholine at the adductor pollicis and laryngeal adductor muscles in anesthetized humans. Anesthesiology 1994; 81: 1110–5.

13 *Plaud B, Debaene B Lequeau F, Meistelman C, Donati F.* Mivacurium neuromuscular block at the adductor muscles of the larynx and adductor pollicis in humans. Anesthesiology 1996; 85: 77–81.

14 *Debaene B, Beaussier M, Meistelman C, Donati F, Lienhart A.* Monitoring the onset of neuromuscular block at the orbicularis oculi can predict good intubating conditions during atracurium- induced neuromuscular block. Anesth Analg 1995; 80: 360–3.

15 *Sayson SC, Mongan PD.* Onset of action of mivacurium chloride. A comparison of neuromuscular blockade monitoring at the adductor pollicis and the orbicularis oculi. Anesthesiology 1994; 81: 35–42.

16 *Davidson JAH, Gillespie JA.* Tracheal intubation after induction of anaesthesia with propofol, alfentanil and i.v. lignocaine. Br J Anaesth 1993; 70: 163–6.

17 *Mulholland D, Carlisle RJT.* Intubation with propofol augmented with intravenous lignocaine. Anaesthesia 1991; 46: 312–3.