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Assessment of intubating conditions in adults after induction with propofol and varying doses of remifentanil

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Summary

We have assessed intubating conditions in three groups of 60 ASA I or II patients after induction of anaesthesia with propofol 2 mg kg^{-1} and remifentanil 0.5, 1.0 or 2.0 μg kg^{-1}. Tracheal intubation was graded according to ease of laryngoscopy, position of the vocal cords, coughing, jaw relaxation and movement of the limbs. Intubation was successful in 80%, 90% and 100% of patients after remifentanil 0.5, 1.0 or 2.0 μg kg^{-1}, respectively. Overall intubating conditions were regarded as acceptable in 20%, 50% and 80% of patients, respectively. All three groups had a decrease in arterial pressure after induction but there was no difference between groups. The decrease in arterial pressure was not regarded as clinically significant. Intubating conditions were best after induction with remifentanil 2 μg kg^{-1} and propofol 2 mg kg^{-1}. (*Br. J. Anaesth.* 1998; **81**: 540–543).

Keywords: analgesics opioid, remifentanil; anaesthetics i.v., propofol; intubation tracheal

The use of propofol and adjuvants such as short-acting opioids, adrenergic blockers and local anaesthetic agents, may provide adequate conditions for laryngoscopy and tracheal intubation without the need for neuromuscular blocking agents.[1–4] Previous work in premedicated adults showed that tracheal intubation was successful after induction of anaesthesia with alfentanil and propofol and conditions were similar to those achieved with thiopental (thiopentone) and succinylcholine (suxamethonium).[5] Given the pharmacokinetic profile of remifentanil, it was hypothesized that it may also be useful in facilitating tracheal intubation.

After a small pilot study, we designed a prospective, randomized, double-blind study to assess intubating conditions and haemodynamic changes in three groups of premedicated adults. Three doses of remifentanil (0.5, 1.0 and 2.0 μg kg^{-1}) supplementing induction of anaesthesia with propofol 2 mg kg^{-1} were compared.

Patients and methods

After obtaining approval from the Ethics Committee and written informed consent, we studied 60 ASA I or II patients undergoing elective inpatient surgery. Patients whose physical characteristics suggested difficulties in intubation (modified Mallampati score III or IV)[6] and those who had a previously documented failed intubation were excluded. Patients with a history of reactive airways disease, including asthma, and a history of upper gastrointestinal reflux were also excluded. All patients were premedicated with temazepam 20–30 mg and ranitidine 150 mg approximately 1 h before anaesthesia.

On arrival in the anaesthetic room, an 18-gauge cannula was inserted into a peripheral vein, non-invasive arterial pressure, electrocardiogram (ECG) and pulse oximeter (Sp_{O_2}) were attached, and baseline measurements were recorded (pre-induction). Patients were preoxygenated while these variables were recorded. Patients were allocated randomly (using a computer program) before commencement of the study to one of three groups: group I = propofol 2 mg kg^{-1} and remifentanil 0.5 μg kg^{-1}; group II = propofol 2 mg kg^{-1} and remifentanil 1 μg kg^{-1}; and group III = propofol 2 mg kg^{-1} and remifentanil 2 μg kg^{-1}. Assignment to each group was concealed using sealed envelopes. The envelope was opened and remifentanil was prepared by anaesthetist No. 1. The remifentanil solution was diluted to a volume of 10 ml with 0.9% saline. Remifentanil was administered as a slow bolus infusion over 30 s. When the bolus dose of remifentanil was given, propofol 2 mg kg^{-1} was administered as a rapid i.v. bolus by hand-held syringe. When the patient lost consciousness, which was judged by loss of response to command and loss of eyelash reflex, ventilation via a mask was attempted by anaesthetist No. 2 (always J. A. D., who was blinded to the randomization group).

Ease of ventilation was recorded as easy, difficult or impossible. Vital signs were measured 45 s after the bolus dose of propofol (post-induction). If the dose of propofol was not sufficient to produce loss of consciousness, as determined by anaesthetist No. 2, further propofol was titrated in incremental boluses of 20 mg until this was achieved. Ninety seconds after propofol was administered, laryngoscopy was attempted by anaesthetist No. 2. During laryngoscopy and attempted intubation of the trachea, the anaesthetist performing intubation assessed each patient for one of five variables: jaw relaxation, exposure of the vocal cords, position of the vocal cords, patient movement and coughing. The criteria used for ranking these variables are shown in table 1. This

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Table 1 Intubating condition score

	Score			
	1	2	3	4
Jaw relaxation	Complete	Slight tone	Stiff	Rigid
Laryngoscopy	Easy	Fair	Difficult	Impossible
Vocal cords	Open	Moving	Closing	Closed
Coughing	None	Slight	Moderate	Severe
Limb movement	None	Slight	Moderate	Severe

Table 2 Patient data (mean (SD range) or number)

	Group I	Group II	Group III
Sex (m/f)	10/10	5/15	5/15
Age (yr)	46 100–00	45 100–00	47 100–00
Weight (kg)	75 (16.2)	72 (16.8)	71 (13)

is a modification of the scoring system described by Helbo-Hansen, Ravlo and Trap-Andersen.[7] One attempt was allowed at laryngoscopy, and assessment of all variables was made from this attempt. Intubating conditions were judged as acceptable when all scores were 2 or less. If any of the scores were 3 or 4 for any of the five variables, intubating conditions were judged unfavourable. Patients in whom intubation was impossible were given rocuronium 600 $\mu g\ kg^{-1}$ to optimize conditions. Vital signs were recorded (post-intubation). In the event of bradycardia (heart rate less than 50 beat min^{-1}), atropine 500 μg was administered. In the event of a decrease in mean arterial pressure of greater than 25%, ephedrine was administered in 6-mg increments. Anaesthesia was maintained at the discretion of the anaesthetist in charge.

STATISTICAL ANALYSIS

Parametric data were analysed using analysis of variance. A change in arterial pressure or heart rate $>20\%$ was regarded as a clinically significant difference. Chi-square analysis was applied to non-parametric data and Bonferroni correction to multiple comparisons. $P<0.05$ was regarded as significant.

Results

We studied 60 adults in three groups of equal size. The three groups were comparable in age and weight (table 2).

Because 50% of the operating sessions were gynaecological, there was a predominance of female subjects (40 females, 20 males). Intubation was completed successfully in 54 of 60 patients using propofol and remifentanil alone (16 of 20 in group I, 18 of 20 in group II and 20 of 20 in group III). One subject in group I required rocuronium. Additional propofol only (20–80 mg) was required in five subjects in group I. Additional propofol and rocuronium were required in three subjects in group I and in two subjects in group II. All subjects given additional propofol, neuromuscular blocking drug, or both, were subsequently intubated successfully. Subjects who required additional propofol or a neuromuscular blocking agent were defined as having unacceptable intubating conditions. Individual assessment of jaw relaxation, view at laryngoscopy, vocal cord position, limb movement and coughing improved significantly as the dose of remifentanil was increased (fig. 1).

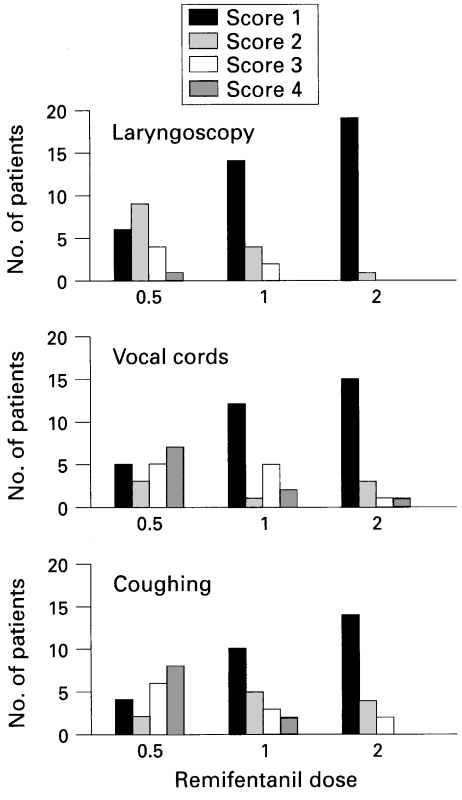

Figure 1 Intubating condition score for laryngoscopy, vocal cords and coughing in patients in each group: 0.5 = Remifentanil 0.5 $\mu g\ kg^{-1}$ and propofol 2 mg kg^{-1}; 1 = remifentanil 1.0 $\mu g\ kg^{-1}$ and propofol 2 mg kg^{-1}; and 2 = remifentanil 2.0 $\mu g\ kg^{-1}$ and propofol 2 mg kg^{-1}.

Muscle rigidity or difficulty with ventilation was not found to be a problem in any of the 60 subjects. Overall assessment for all five variables at intubation is shown in figure 2. A score of 2 or less for all of the criteria in table 1 was deemed as satisfactory intubating conditions. A score of 3 or greater for any of the criteria was categorized as unsatisfactory. Only four of 20 subjects (20%) in group I were judged to have satisfactory intubating conditions compared with 10 of 20 (50%) in group II and 16 of 20 (80%) in group III. There was a statistically significant difference in overall intubation conditions between groups I, II and III ($P<0.05$).

Cardiovascular responses to induction and intubation are shown in figure 3. The initial haemodynamic

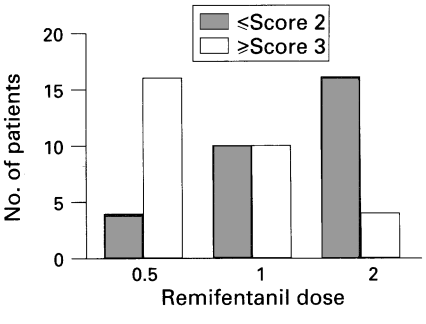

Figure 2 Overall intubating conditions in patients in the three groups. All scores of ≤ 2 = acceptable intubating conditions while any score ≥ 3 = unacceptable intubating conditions. 0.5 = Remifentanil 0.5 $\mu g\ kg^{-1}$ and propofol 2 mg kg^{-1}; 1 = remifentanil 1.0 $\mu g\ kg^{-1}$ and propofol 2 mg kg^{-1}; and 2 = remifentanil 2.0 $\mu g\ kg^{-1}$ and propofol 2 mg kg^{-1}.

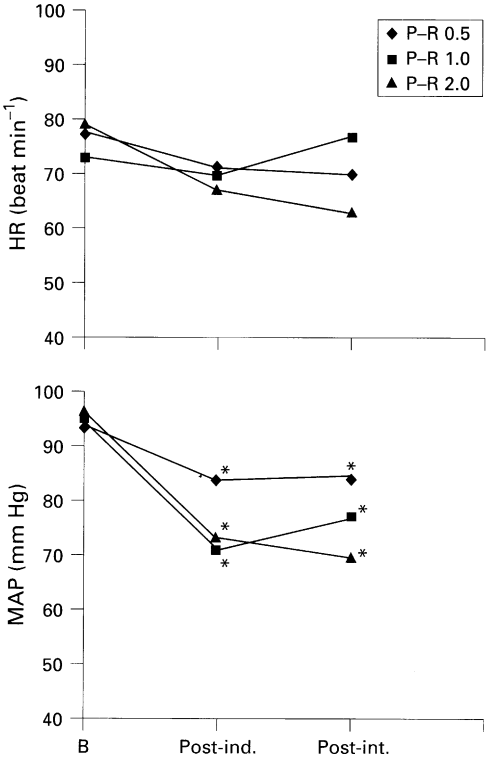

Figure 3 Heart rate (HR) and arterial pressure (MAP) responses to laryngoscopy and intubation after propofol–remifentanil 0.5 μg kg^{-1} (P–R 0.5), propofol–remifentanil 1.0 μg kg^{-1} (P–R 1.0) and propofol–remifentanil 2.0 μg kg^{-1} (P–R 2.0). Within-group significant changes compared with values before induction: *$P<0.05$. B = Baseline; Post-ind. = after induction; Post-int. = after intubation.

variables were similar in the three groups. There was a decrease in heart rate after induction in all three groups but this was not clinically or statistically significant. No patient required atropine. The decrease in arterial pressure after induction and intubation in all three groups was statistically significant compared with baseline, but was not regarded as clinically significant. There were no significant differences in arterial pressures between groups at any time. Two patients in group III were given ephedrine.

Discussion

Our data demonstrated that tracheal intubation was possible in premedicated adults with favourable airway anatomy after i.v. induction with remifentanil and propofol. In combination with propofol 2 mg kg^{-1}, the best conditions achieved in this study were with remifentanil 2 μg kg^{-1}.

Previous studies have concluded that intubation is possible without the use of neuromuscular blocking agents. Using only propofol 2.5 mg kg^{-1}, Keaveney and Knell[1] reported satisfactory intubating conditions in 12 of 20 patients. Saarnivaara and Klemola[2] assessed various doses of alfentanil in premedicated adult patients and produced successful intubation in 86% of patients using alfentanil 30 μg kg^{-1} and propofol 2.5 mg kg^{-1}. A similar success rate was reported by Coghlan, McDonald and Csepregi who studied unpremedicated adults and achieved successful intubation in 83% of patients using alfentanil 20 μg kg^{-1} and propofol 2.5 mg kg^{-1} [3]. Scheller, Zornow and Saidman[5] studied 75 patients (group I received tubocurarine 3 mg, thiopental 4 mg kg^{-1} and succinylcholine 1 mg kg^{-1} and groups II–V alfentanil 30, 40, 50 or 60 μg kg^{-1} combined with propofol 2 mg kg^{-1}). They concluded that in premedicated patients with favourable airway anatomy receiving alfentanil 40 μg kg^{-1} and propofol for induction, intubating conditions and patient response to intubation differed little from those achieved with thiopental and succinylcholine.

Remifentanil is 20–25 times more potent than alfentanil. If our results are compared with the equally potent alfentanil 40 μg kg^{-1} group in Scheller's study, remifentanil 2 μg kg^{-1} combined with propofol is comparable in terms of intubation and haemodynamic response. It has been suggested by Steyn and colleagues[8] that by aiming for a defined clinical endpoint at induction of anaesthesia rather than fixing the dose of propofol at 2 mg kg^{-1}, it might be possible to improve intubating conditions further and reduce side effects such as hypotension. However, even with the fixed dose of propofol in our study, the mean decrease in arterial pressure was not clinically significant. But we would add a caution to the use of this technique in the elderly or compromised patient. The decrease in arterial pressure which was compensated for by the reasonably healthy subjects in our study might not be as well tolerated in less healthy patients. The need for dose reduction in the elderly or compromised patient is an area of further study. A small percentage of patients in this study experienced coughing after intubation but this did not interfere with passage of the tracheal tube.

The effects of remifentanil are short acting,[9] and timing to achieve the maximum effect of the combination of propofol and remifentanil is important. Using a computerized pharmacokinetic model, we determined that peak blood concentrations would be approximately 6 ng ml^{-1} and that these would be achieved at approximately 90 s after our 30-s infusion of remifentanil 2 μg kg^{-1}.

The short duration of action of remifentanil may confer an advantage over alfentanil where there are problems with prolonged apnoea in short surgical cases.[5] Metabolism of alfentanil has been shown to be very variable.[10] It is dependant on cytochrome P450 A34 and there is large inter-individual variation in the activity of this enzyme. Remifentanil is metabolized by non-specific tissue esterases and has a reliable context-sensitive half-life of approximately 3 min.[11] This short half-life is not relevant however, if remifentanil and propofol are supplemented rapidly by inhalation anaesthetics after intubation.

In the event of a prolonged difficult intubation which is predicted or, more importantly, unexpected, we feel this technique is advantageous. It allows assessment of the airway by laryngoscopy and also importantly if oxygenation is possible. The decision whether or not to awaken the patient or proceed can then be made.

The reliably short duration of apnoea is the main advantage of remifentanil compared with alfentanil. We note from our clinical experience with this technique that the duration of apnoea is similar to that with succinylcholine. The design of this dose-finding study made it impossible to assess the duration of apnoea scientifically and a follow-on study examining this is underway.

We see a potential use for this technique in ENT and gynaecological anaesthesia and in any case

where intubation is necessary but neuromuscular block is not required to facilitate surgical access. We also see potential use in cases where neuromuscular blocking agents are contraindicated (e.g. myopathies) or where succinylcholine is contraindicated but a rapid sequence technique is required (e.g. hyperkalaemia, burns, plasma cholinesterase deficiency or penetrating eye injury).

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