

Prophylaxis against the systemic hypotension induced by propofol during rapid-sequence intubation

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The objective of this study was to determine the effectiveness of two prophylactic approaches against the anticipated hypotension induced by propofol during rapid-sequence intubation. Thirty-six male or female nonpremedicated ASA class I-II patients aged 21-60 yr undergoing elective outpatient surgery were included in the study. Patients were randomly allocated to receive pre-induction ephedrine sulphate ($70 \mu\text{g} \cdot \text{kg}^{-1}$ iv), pre-induction volume loading ($12 \text{ ml} \cdot \text{kg}^{-1}$ Ringer's lactate) or no treatment. Rapid-sequence intubation with cricoid pressure was then performed with propofol ($2.5 \text{ mg} \cdot \text{kg}^{-1}$) and succinylcholine ($1.5 \text{ mg} \cdot \text{kg}^{-1}$). The lungs were subsequently ventilated with 0.25-0.5% isoflurane in a 2:1 $\text{N}_2\text{O}/\text{O}_2$ mixture. Vecuronium was given once neuromuscular function had recovered from the succinylcholine. Heart rate and systemic arterial blood pressure were measured non-invasively before induction, after propofol administration and every minute for ten minutes after intubation. Pre-induction volume loading prevented the hypotension observed before surgical stimulation in control and ephedrine groups. Moreover, pre-induction volume loading was not associated with increases in heart rate after intubation as was ephedrine administration. The intubating conditions were excellent to satisfactory in most patients and the overall incidence of adverse events during induction was mainly due to pain during injection of propofol. The present study showed that preoperative volume loading is more efficacious than pre-

induction administration of ephedrine sulphate in maintaining haemodynamic stability during rapid-sequence induction with propofol and succinylcholine. In addition, propofol in combination with succinylcholine provides excellent conditions for rapid-sequence intubation.

Cette étude a pour objet de déterminer l'efficacité de deux approches visant à prévenir l'hypotension induite par le propofol pendant l'induction en séquence rapide. Trente-six patients des deux sexes non prémédiqués de classe ASA I et II âgés de 21 à 60 ans programmés en chirurgie ambulatoire font partie de l'étude. Les patients sont répartis au hasard pour recevoir du sulfate d'éphédrine ($70 \mu\text{g} \cdot \text{kg}^{-1}$ iv) avec une charge liquidienne ($12 \text{ ml} \cdot \text{kg}^{-1}$ de lactate de Ringer) ou aucun traitement. L'intubation en séquence rapide avec pression cricoïdienne est exécutée sous propofol ($2,5 \text{ mg} \cdot \text{kg}^{-1}$) et succinylcholine ($1,5 \text{ mg} \cdot \text{kg}^{-1}$). La ventilation mécanique est ensuite initiée avec de l'isoflurane 0,25 à 0,5% dans un mélange $\text{N}_2\text{O}/\text{O}_2$ 2:1. Du vécuronium est administré après récupération de la succinylcholine. La fréquence cardiaque et la pression artérielle systémique sont mesurées avant l'induction et à toutes les minutes pendant dix minutes. La charge liquidienne préinduction prévient l'hypotension observée avant la stimulation chirurgicale dans les groupes contrôles et éphédrine. En outre, la charge liquidienne préinduction n'est pas associée à une augmentation de la fréquence cardiaque après l'intubation comme l'est l'éphédrine. Les conditions d'intubation sont excellentes dans la plupart des cas et les complications se limitent presque totalement à de la douleur au moment de l'injection du propofol. La présente étude montre que la charge liquidienne préinduction est plus efficace que l'administration de sulfate d'éphédrine pour maintenir la stabilité hémodynamique pendant l'induction à séquence rapide avec le propofol et la succinylcholine. D'ailleurs, l'association de propofol et de succinylcholine procure d'excellentes conditions pour l'intubation en séquence rapide.

Key words

ANAESTHETICS, INTRAVENOUS: propofol;
COMPLICATIONS: hypotension;
INTUBATION, TRACHEAL: rapid sequence;
SYMPATHOMIMETICS: ephedrine sulfate.

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Rapid-sequence induction of anaesthesia is a challenging situation for the anaesthetist. The major considerations are rapid protection of the airway by a cuffed endo-

tracheal tube, prevention of laryngospasm, regurgitation, vomiting and aspiration and maintenance of haemodynamic stability. The use of propofol may have several potential advantages that can achieve the major objectives of a rapid-sequence intubation technique. Propofol provides fast onset of action,¹ potent attenuation of pharyngeal, laryngeal and tracheal reflexes² and adequate depth of anaesthesia during intubation.^{1,3} However, a major disadvantage of rapid propofol bolus induction is the considerable decrement in systemic arterial blood pressure.^{4,5}

This report determines the efficacy of two prophylactic approaches against the anticipated propofol-induced hypotension. The report also evaluates the use of propofol as the sole hypnotic agent during rapid-sequence intubation.

Methods

The study was approved by the Human Research Ethics Board of Queen's University. Thirty-six male or female unpremedicated ASA physical status 1 or 2 patients aged 21–60 yr were included in the study after they signed an informed consent. All patients were scheduled to undergo ambulatory surgery in whom rapid-sequence induction was not absolutely indicated. Surgical procedures performed were pelvic laparoscopy, arthroscopy and hand surgery. The exclusion criteria were a history of (1) allergy to the study medications; (2) uncontrolled cardiovascular, respiratory, hepatic or renal disease; (3) controlled or uncontrolled hypertension; (4) therapy with diuretics or vasoactive medications and (5) morbid obesity and pregnancy. Patients included in the study were allocated randomly into three groups: patients assigned to Group I did not receive any pretreatment before induction while those in Group II received ephedrine sulphate ($70 \mu\text{g} \cdot \text{kg}^{-1} \text{ iv}$) just before induction of anaesthesia. Patients in Group III were volume loaded with Ringer's lactate ($12 \text{ ml} \cdot \text{kg}^{-1}$) over the 10–15 min before the administration of propofol. After pre-oxygenation for three minutes and pre-curarization with d-tubocurarine 3 mg iv , propofol $2.5 \text{ mg} \cdot \text{kg}^{-1}$ bolus without lidocaine was administered in $<10 \text{ sec}$ and followed immediately by cricoid pressure and succinylcholine ($1.5 \text{ mg} \cdot \text{kg}^{-1} \text{ iv}$). Laryngoscopy, orotracheal intubation and cuff inflation were carried out 30 sec later. After confirming the position of the endotracheal tube, positive-pressure ventilation was started with the administration of 0.25–0.5% isoflurane in a 2:1 $\text{N}_2\text{O}/\text{O}_2$ gaseous mixture. Vecuronium, $0.06 \text{ mg} \cdot \text{kg}^{-1}$, was given once neuromuscular function had recovered from succinylcholine.

Preoperative baseline values of heart rate and blood pressure were the average of two consecutive readings at least ten minutes apart recorded in the Outpatient De-

TABLE I Grading of intubating conditions⁶

Grade	Criteria
Excellent	Good jaw relaxation, vocal cords open, no response to intubation
Satisfactory	Good jaw relaxation, vocal cords open, minimal reaction to intubation
Fair	Jaw relaxed, cords moving, intubation requiring firm pressure and accompanied by moderate bucking or coughing
Poor	Intubation impossible because of poor jaw or cord relaxation

partment. During the perioperative period, the heart rate and blood pressure were measured just before induction, after the administration of propofol and every minute for ten minutes after intubation using an automatic non-invasive blood pressure monitor. No surgical stimulation was performed until the first ten minutes after induction was completed to ensure no untoward extraneous effect on patients' physiological variables during the study period. Any complications during induction, i.e., somatic movements, vomiting, convulsions, laryngospasm and coughing, were charted. Intubating conditions were classified as: excellent, satisfactory, fair and poor (Table I).⁶

Data are expressed as percentages of the baseline preoperative values (mean \pm SD). Intragroup analysis was performed on raw data using one-way analysis of variance (ANOVA), followed by post-hoc Neuman-Keul's test for comparison with baseline. Comparison among groups was determined using two-way ANOVA for repeated measurements and the Mann-Whitney U-test.⁷ Differences were considered significant when $P < 0.05$.

Results

Twenty women and 16 men were included in the study. The mean age and weight were $30 \pm 7.5 \text{ yr}$ and $77 \pm 12.5 \text{ kg}$ for the control group, $29 \pm 6.7 \text{ yr}$ and $69 \pm 15.7 \text{ kg}$ for the ephedrine group and $34 \pm 8.1 \text{ yr}$ and $72.6 \pm 14.5 \text{ kg}$ for the volume loading group, respectively, and these were not significantly different. The difference among the three groups in male/female ratio, baseline systolic (SBP) and diastolic blood pressure and heart rate were not different. The SBP (mean \pm SD mmHg) and the heart rate (mean \pm SD beats/min) in control, ephedrine and volume loading groups were 120 ± 15.3 and 82 ± 22 , 126 ± 17.9 and 82 ± 18 and 122 ± 19 and 80 ± 16 respectively.

In the control group, the mean SBP just after propofol induction was $115 \pm 12.8 \text{ mmHg}$ ($4.2 \pm 3\%$ less than the mean preoperative value). Immediately after intubation the SBP increased to $133 \pm 14.2 \text{ mmHg}$ and ten minutes later decreased to $82 \pm 9.2 \text{ mmHg}$ representing

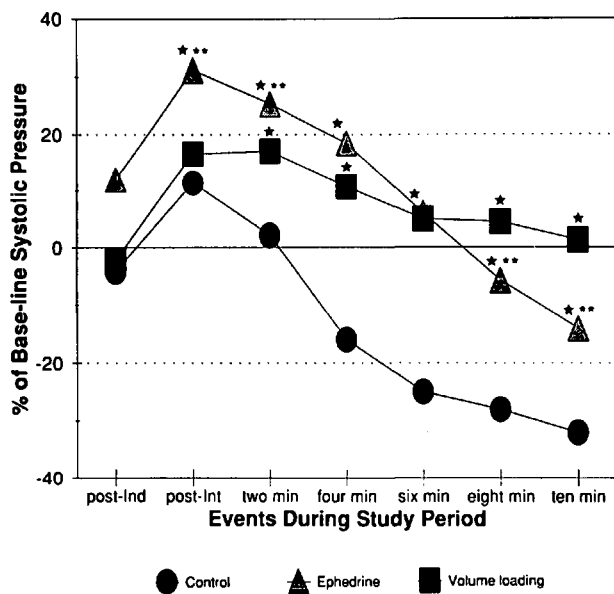


FIGURE 1 Mean changes in systolic arterial blood pressure during the study period in control, ephedrine and volume loading groups. Systolic pressure readings shown in the figure were recorded post-intubation (post-ind), post-intubation (post-int) and every two minutes after intubation. (★) and (★★) indicate statistical significance ($P < 0.05$) from control and volume loading groups respectively.

11.4 ± 8.4% increase and 32.4 ± 7% decrease from base-line (Figure 1). This pattern changed with pretreatment with ephedrine sulphate and with pre-induction loading with Ringer's lactate (Figure 1). In the ephedrine group there was an increase, rather than a decrease, in the post-intubation SBP to 139 ± 17 mmHg. The SBP reached a peak of 165 ± 18.3 mmHg just after intubation. However, ten minutes post-intubation the SBP was 108 ± 10.7 mmHg, i.e., 14.1 ± 8.7% less than baseline values. Pre-induction loading with Ringer's lactate did not increase the blood pressure postinduction as with ephedrine. Most importantly, volume loading prevented the delayed hypotension observed ten minutes after tracheal intubation in the control and ephedrine groups (Figure 1). The changes in the heart rate were statistically significant in the ephedrine group; post-intubation, immediately post-intubation, and ten minutes post-intubation heart rates were 108 ± 10, 122 ± 9 and 94 ± 9 beat/min⁻¹ respectively indicating an increase from preoperative values by 25.6, 41.9 and 10.6% (Figure 2). These changes were different from preoperative values and from the changes observed in control and volume loading groups.

The intubating conditions are shown in Table II. Intubations were graded as excellent and satisfactory in 94.4% of all the patients enrolled in the study without statistical difference between the groups. In two patients

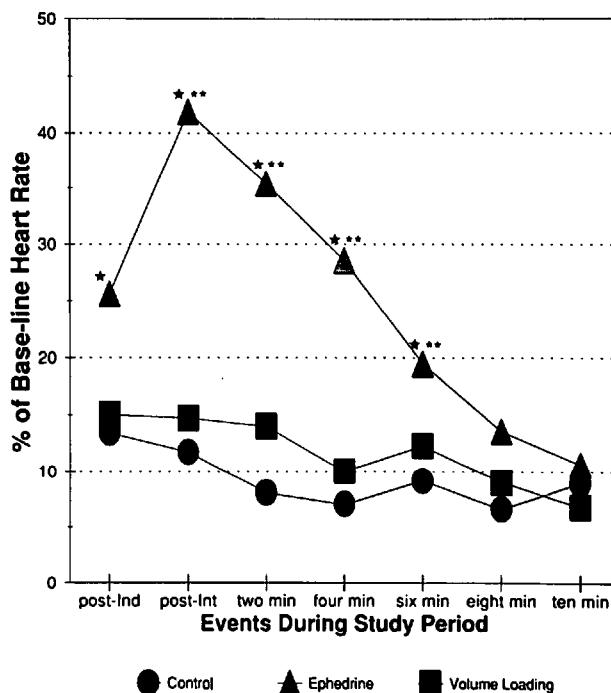


FIGURE 2 Mean changes in heart rate during the study period in control, ephedrine and volume loading groups. (★) and (★★) indicate statistical significance ($P < 0.05$) from control and volume loading groups respectively.

TABLE II Grading of the intubating conditions during rapid-sequence induction with propofol and succinylcholine

Intubating conditions	Control n = 12	Ephedrine n = 12	Volume loading n = 12
Excellent	9/12	10/12	8/12
Satisfactory	2/12	1/12	4/12
Fair	1/12	1/12	0/12
Poor	0/12	0/12	0/12

the intubating conditions were graded as fair. The overall incidence of adverse events during induction with propofol was 19.4%. Of these side effects, 11.1% were due to pain during injection. None of the complications prevented tracheal intubation. One patient in the ephedrine group had laryngospasm which was relieved after the administration of succinylcholine. During this incident the level of oxygen saturation did not decrease below 96%.

Discussion

This report evaluated the pre-induction use of *iv* ephedrine sulphate or volume loading with Ringer's lactate as prophylactic measures against systemic hypotension induced by propofol induction during rapid-sequence in-

tubation. These approaches have been previously used safely and studied extensively during the conduction of neuroaxial blocks⁸ and high-dose opioid induction of anaesthesia.⁹ The rationale for the prophylactic use of sympathomimetics or crystalloid loading is to attenuate the anticipated decrements in the systemic vascular resistance or to maintain the right ventricular filling pressure respectively.

In our investigations, the blood pressure response in the control group could be divided into three phases: post-induction decrease, post-intubation increase and a gradual decline reaching a peak ten minutes post-intubation (Figure 1). The slight initial reduction in SBP immediately after the propofol bolus is in disagreement with the 20–30% reduction in SBP observed in previous investigations.^{4,5} This may be due to the very short induction-intubation time, which is a necessary component of the rapid-sequence induction technique. The mean increase in the arterial systemic pressure after intubation represents the antagonism between the propofol-induced hypotension and the stress response to laryngoscopy and intubation. The mean peak decline in SBP by ~30% ten minutes after intubation is mainly due to 2.5 mg · kg⁻¹ propofol induction dose. However, a combination of other factors may have potentiated the observed hypotension, i.e., institution of positive-pressure ventilation and administration of isoflurane 0.25–0.5%.

Administration of ephedrine sulphate immediately before induction produced modest post-induction hypertension, enhanced the post-intubation hypertension and failed to protect against the delayed hypotension observed in the control group (Figure 1). There also were considerable increases in the heart rates with a maximum mean of 41.9% just after intubation. On the other hand, pre-induction volume loading with Ringer's lactate abolished the post-induction decrease in SBP and the ten minute post-intubation hypotension (Figure 1). The slight heart rate increases in the volume loading group were not different from preoperative values or from those of the control group but were less than those from the ephedrine group (Figure 2). Therefore, pre-induction volume loading with Ringer's lactate provides more haemodynamic stability than the pre-induction administration of ephedrine sulphate *iv* during rapid-sequence intubation.

There is little information about the use of propofol as the sole *iv* hypnotic agent with succinylcholine during rapid-sequence induction. In a recent abstract, Merk and Goudsouzian¹⁰ compared the intubating conditions achieved with the use of propofol or thiopentone each in combination with atracurium or succinylcholine. In agreement with our observations, the intubating conditions were excellent to satisfactory in about 90% of the

patients whose tracheas were intubated after induction with propofol and succinylcholine.

In conclusion, the use of propofol with succinylcholine during rapid-sequence induction of anaesthesia allowed rapid and smooth placement of the endotracheal tube without severe critical incidents. Preoperative ephedrine sulphate administration failed to prevent the delayed post-intubation hypotension and led to excessive increases in the heart rate that may not be tolerated in high risk patients. On the other hand, preoperative volume loading with 12 ml · kg⁻¹ Ringer's lactate over 10–15 min successfully antagonised propofol-induced hypotension without increments in heart rate.

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