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Comparative evaluation of TIVA with propofol-fentanyl and thiopental-sevoflurane anesthesia using laryngeal mask airway for diagnostic bronchoscopy

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Abstract

Purpose. Diagnostic bronchoscopy is performed under general anesthesia in our hospital. This study was designed to determine whether total intravenous anesthesia (TIVA) with propofol-fentanyl provides more stable hemodynamics using a laryngeal mask airway (LMA) for diagnostic bronchoscopy than thiopental-sevoflurane anesthesia.

Methods. Sixty patients scheduled for diagnostic bronchoscopy were randomly assigned to two groups. TIVA with propofol-fentanyl was induced with intravenous fentanyl 2 μg·kg^{-1} and propofol 2 mg·kg^{-1} and maintained with continuous infusion of propofol with fentanyl. Thiopental-sevoflurane anesthesia was induced with thiopental 5 mg·kg^{-1} and maintained with N_2O/O_2/sevoflurane. Insertion of the LMA was facilitated with vecuronium 0.1 mg·kg^{-1} i.v. in both groups. Ventilation was controlled, and administration of propofol and sevoflurane was continued until the end of the procedure. The LMA was removed when the patient was able to open his or her mouth.

Results. During TIVA, the mean arterial pressure and rate pressure product decreased significantly from induction until 20 min after the start of the procedure, and they were maintained at around 70 mmHg and 7000, respectively, during the procedure. There were no significant differences in heart rate, Sp_{O_2} and PET_{CO_2}. In thiopental-sevoflurane anesthesia, the mean arterial pressure and rate pressure product decreased significantly after induction and increased significantly from insertion of the LMA until removal of the LMA. Heart rate increased significantly after insertion of the LMA, insertion of the bronchoscope, and removal of the LMA. There were no significant differences in Sp_{O_2} and PET_{CO_2}.

Conclusion. TIVA with propofol-fentanyl in conjunction with an LMA performs better than thiopental-sevoflurane anesthesia for diagnostic bronchoscopy because of its superior maintenance of cardiovascular stability.

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Introduction

General anesthesia with inhalational agents or topical anesthesia has been used for diagnostic bronchoscopy. However, it is difficult to achieve stable hemodynamics during the procedure with these methods because bronchoscopy produces strong noxious stimulation. To achieve stable anesthesia during diagnostic bronchoscopy, we have recently used laryngeal mask airway (LMA) and total intravenous anesthesia (TIVA) with propofol-fentanyl, which seems to produce greater cardiovascular stability. The rapid onset and recovery time of propofol is beneficial for bronchoscopy, and TIVA provides a high concentration of oxygen during the procedure, when this is necessary. The purpose of this study is to clarify the differential effects on hemodynamic changes by comparing TIVA with propofol-fentanyl and thiopental-sevoflurane anesthesia, using an LMA for diagnostic bronchoscopy.

Materials and methods

After the approval of the hospital ethics committee and the informed consent of the patients had been obtained, 60 adult patients of ASA I or II, aged between 34 and 65 years, who were scheduled for fiber-optic bronchoscopy were randomly assigned to receive TIVA with propofol-fentanyl or nitrous oxide in oxygen with sevoflurane. Patients with hypertension, ischemic heart disease, or hepatic, renal, or neuromuscular diseases were excluded from the study.

All patients were premedicated with intramuscular atropine 0.5 mg, hydroxyzine 50 mg, and ranitidine

50 mg 1 h before surgery. On arrival at the operating room, the electrocardiogram, indirect arterial pressure, and pulse oximetry (Satlite, Datex, Finland) were monitored.

Baseline readings were recorded before the induction of anesthesia. Propofol anesthesia was induced with intravenous fentanyl 2 $\mu g \cdot kg^{-1}$ and propofol 2 $mg \cdot kg^{-1}$, and the patients were ventilated manually with oxygen through a face mask. Vecuronium 0.1 $mg \cdot kg^{-1}$ was administered intravenously, followed by intravenous infusion of propofol 10 $mg \cdot kg^{-1} \cdot h^{-1}$. Three minutes after the administration of vecuronium, an LMA was inserted blindly by the anesthesiologist. Anesthesia was maintained with intravenous infusion of propofol using the step-down method [1]. Vecuronium was added as necessary during the procedure. The lungs of all patients were mechanically ventilated with an admixture of oxygen (50%) and air. The patients were given increments of fentanyl 0.5 $\mu g \cdot kg^{-1}$ at 30-min intervals. Sevoflurane anesthesia was induced with intravenous thiopental 5 $mg \cdot kg^{-1}$, and the patients were ventilated manually with oxygen and sevoflurane using a face mask. Three minutes after the administration of vecuronium 0.1 $mg \cdot kg^{-1}$, an LMA was inserted by the anesthesiologist. Anesthesia was maintained with nitrous oxide in oxygen (50%) supplemented with sevoflurane at an end-tidal concentration of 1.0%–2.5%. In general, a size 3 LMA was used for women and a size 4 for men. Ventilation was controlled using a suction connector (Bodai Suction Safe, Swivel Y, Sontek Medical, USA) between the LMA and the corrugated tube of the anesthetic machine to keep an airtight connection during the procedure. Propofol or sevoflurane administration continued until the end of the procedure. The neuromuscular blockade was reversed with slow administration of neostigmine 2 mg with atropine 1 mg. The LMA was removed once the patient was able to open his or her mouth on command. All patients were monitored in the recovery room, and we confirmed their respiratory and circulatory stability before they were discharged to the ward.

The mean arterial pressure, heart rate, Sp_{o_2}, and $P_{ET_{CO_2}}$ were recorded at baseline (prestudy), before induction, just after induction, just after insertion of the LMA, just after insertion of the bronchoscope, 10 and 20 min after the start of the procedure, immediately after removal of the LMA, and before leaving the operating room.

The data are presented as means ± SD. Demographic data were compared using Student's t-test. Intergroup differences were analyzed by repeated-measures ANOVA with Bonferroni's correction as post hoc testing. Comparisons between both groups were made by the Mann-Whitney U test. Statistical significance was considered to be $P < 0.05$.

Results

The demographic data are summarized in Table 1. There were no significant differences between the groups in age, weight, or height. The preponderance of males is explained by the higher incidence of pulmonary diseases in men. The duration of anesthesia, duration of the procedure, and time from the end of the procedure to removal of the LMA are summarized in Table 2. There were no significant differences between the groups in these mensurements.

Hemodynamics

The changes in mean arterial pressure are shown in Fig. 1. In TIVA with propofol-fentanyl, the mean arterial pressure decreased significantly from induction until 20 min after the start of the procedure as compared to the baseline value ($P < 0.05$). The mean arterial pressure was maintained around 70 mmHg during the procedure. Insertion of the LMA and bronchoscope caused only minor changes in arterial pressure. In thiopental-sevoflurane anesthesia, the mean arterial pressure decreased significantly after induction and increased significantly from insertion of the LMA until removal of the LMA ($P < 0.05$). The mean arterial pressure in thiopental-sevoflurane anesthesia was higher than that in TIVA with propofol-fentanyl during the procedure. In TIVA with propofol-fentanyl, there was no significant difference in heart rate, but in thiopental-sevoflurane anesthesia, the heart rate increased significantly after insertion of the LMA, insertion of the bronchoscope, and removal of the LMA ($P < 0.05$) (Fig. 2). In TIVA with propofol-fentanyl, the rate

Table 1. Demographic data (mean ± SD)

Feature	Propofol	Sevoflurane
Age (yr)	55 ± 7	54 ± 6
Weight (kg)	56 ± 9	54 ± 8
Height (cm)	157 ± 13	159 ± 13
Males/females	21:9	23:7

Table 2. Duration of anesthesia, duration of the procedure, and duration from the end of the procedure to removal of the LMA (mean ± SD)

Time (min)	Propofol	Sevoflurane
Duration of anesthesia	65 ± 21	62 ± 19
Duration of procedure	42 ± 18	46 ± 16
Duration from end of procedure to removal of LMA	14 ± 12	17 ± 13

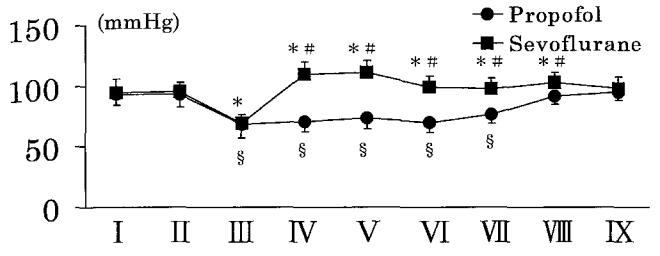

Fig. 1. Changes in mean arterial pressure. *I* Baseline, *II* before induction, *III* after induction, *IV* after insertion of laryngeal mask airway (LMA), *V* after insertion of bronchoscope, *VI* 10 min after insertion of bronchoscope, *VII* 20 min after insertion of bronchoscope, *VIII* removal of LMA, *IX* before leaving operating room. Values expressed as means ± SD. $*P < 0.05$ *vs* baseline (Sevoflurane). $\S P < 0.05$ *vs* baseline (Propofol). $\#P < 0.05$ *vs* propofol

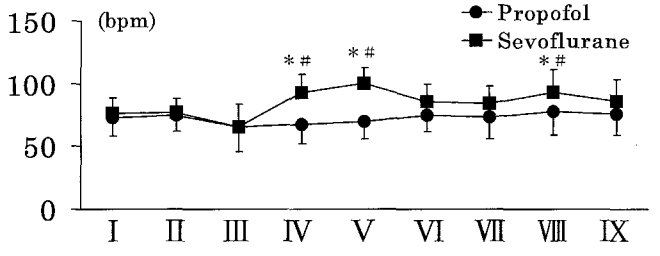

Fig. 2. Changes in heart rate. *I* Baseline, *II* before induction, *III* after induction, *IV* after insertion of LMA, *V* after insertion of bronchoscope, *VI* 10 min after insertion of bronchoscope, *VII* 20 min after insertion of bronchoscope, *VIII* removal of LMA, *IX* before leaving operating room. Values expressed as mean ± SD. $*P < 0.05$ *vs* baseline (Sevoflurane). $\#P < 0.05$ *vs* propofol

pressure product decreased significantly from induction until 20 min after the start of the procedure as compared with the baseline value ($P < 0.05$), and was maintained at 7000 to 8000 during the procedure. In thiopental-sevoflurane anesthesia, however, it increased significantly from insertion of the LMA until removal of the LMA ($P < 0.05$), and remained at 11000 to 15000. Therefore, the rate pressure product in thiopental-sevoflurane anesthesia increased significantly from insertion of the LMA until removal of the LMA as compared with that in TIVA with propofol-fentanyl ($P < 0.05$).

Sp_{O_2} and $P_{ET_{CO_2}}$

Since Fi_{O_2} was maintained at 50%, Sp_{O_2} was maintained at 96% to 100% during the procedure in both groups. There was no significant difference between them. $P_{ET_{CO_2}}$ was maintained at 35 to 45 mmHg during the procedure in both groups. There was no significant difference between them.

Complications

Three patients in the group receiving TIVA with propofol-fentanyl noticed pain on intravenous injection. Two patients receiving thiopental-sevoflurane anesthesia complained of nausea within 24 h after anesthesia. However, there were no major complications associated with either anesthetic technique.

Discussion

Diagnostic bronchoscopy is usually performed with topical anesthesia and/or sedation [2–4] in the awake patient. It may also induce hemodynamic changes, including tachycardia, arrhythmia, and hypertension. These have been described as sympatho-adrenal responses resulting from noxious stimuli to the upper respiratory tract [5]. This suggests that bronchoscopy on the awake patient exerts significantly detrimental cardiovascular effects on elderly patients and patients with heart disease. The oxygen supply to the heart may be impaired by tachycardia, and myocardial oxygen consumption increases with hypertension and tachycardia, thereby precipitating episodes of myocardial oxygen imbalance and ischemia [6]. Therefore, we have used general anesthesia for diagnostic bronchoscopy. In this study, we compared cardiovascular changes during bronchoscopy using TIVA with propofol-fentanyl or thiopental-sevoflurane anesthesia.

With thiopental-sevoflurane anesthesia, we could not prevent the increase of arterial pressure and heart rate after insertion of the LMA and bronchoscope, even if we used thiopental 5 mg·kg^{-1} with a high concentration of sevoflurane. However, it is well known that laryngoscopy and stimuli inside the trachea are more stressful than incision or closure of the abdomen [7]. Thiopental-sevoflurane anesthesia did not provide as much cardiovascular stability in the face of stimuli to the trachea as did TIVA with propofol-fentanyl, since the rate pressure product increased significantly during the procedure and reached 15000 after insertion of the bronchoscope.

There is evidence to suggest that propofol may obtund the hemodynamic responses to noxious stimuli produced by anesthesia and surgery [6,8]; moreover, the addition of opioids reduces these responses [9]. In our study, TIVA with propofol-fentanyl reduced the hemodynamic response to the stimuli of the LMA and bronchoscopy, although we did not use nitrous oxide.

The guidelines published in 1993 by the British Thoracic Society for care during bronchoscopy state that the arterial oxygen saturation should be maintained at 90% or greater [10]. However, Crawford et al. [2] reported that the arterial oxygen saturation fell below 90% during awake bronchoscopy. Since TIVA provides high concentrations of oxygen during the procedure, it is more advantageous, to use TIVA during bronchoscopy than to perform bronchoscopy on the awake patient.

Previous studies have demonstrated that the LMA is useful for fiberoptic bronchoscopy because it provides a view of the vocal cord and subglottic area [11–13]. Since use of the LMA also avoids laryngoscopy and intubation of the trachea, which induce a marked increase in arterial pressure and heart rate, we used the LMA for diagnostic bronchoscopy. However, we could not prevent the rise of arterial pressure even after insertion of the LMA under thiopental-sevoflurane anesthesia.

Pain on intravenous injection of propofol occurs in as many as 50% of patients if the smaller veins on the dorsum of the hand are used [14,15]. Since we used the larger veins of the forearm and pretreated with fentanyl, the incidence of pain was only 10%. After thiopental-sevoflurane anesthesia, two patients felt nausea. However, there were no nauseated patients in the TIVA group because propofol has an antiemetic effect [17,18].

In conclusion, TIVA with propofol-fentanyl when an LMA is used is useful for diagnostic bronchoscopy because it prevents cardiovascular instability caused by noxious stimuli to the trachea during the procedure.

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