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Original contribution

The optimal effect-site concentration of remifentanil for lightwand tracheal intubation during propofol induction without muscle relaxation

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Abstract

Study Objective: To determine the most suitable effect-site concentration of remifentanil during lightwand intubation when administered with a target-controlled infusion (TCI) of propofol at 4.0 μg/mL without neuromuscular blockade.

Design: Prospective study using a modified Dixon's up-and-down method.

Setting: Operating room of an academic hospital.

Patients: 28 ASA physical status 1 and 2 patients, aged 18-65 years, scheduled for minor elective surgery.

Interventions: Anesthesia was induced by TCI propofol effect-site concentration to 4.0 μg/mL, and the dose of remifentanil given to each patient was determined by the response of the previously tested patient using 0.2 ng/mL as a step size. The first patient was tested at a target effect-site concentration of 4.0 ng/mL of remifentanil. If intubation was successful, the remifentanil dose was decreased by 0.2 ng/mL; if it failed, the remifentanil dose was increased by 0.2 ng/mL. Successful intubation was defined as excellent or good intubating conditions.

Measurements and Main Results: The remifentanil effect-site concentration was measured. The optimal effect-site concentration of remifentanil for lightwand tracheal intubation during propofol induction using 2% propofol target effect-site concentration to 4 μg/mL was 2.16 ± 0.19 ng/mL. From probit analysis, the effect-site concentration of remifentanil required for successful lightwand intubation in 50% (EC50) and 95% (EC95) of adults was 2.11 ng/mL (95% CI 1.16-2.37 ng/mL) and 2.44 ng/mL (95% CI 2.20-3.79 ng/mL), respectively.

Conclusion: A remifentanil effect-site concentration of 2.16 ± 0.19 ng/mL given before a propofol effect-site concentration of 4 μg/mL allowed lightwand intubation without muscle relaxant.

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1. Introduction

Lightwand tracheal intubation is a technique in which an illumination stylet is introduced into the endotracheal tube (ETT) and the tip of the ETT is directed into the trachea guided by transillumination of the neck tissues [1,2]. Lightwand tracheal intubation is a simple technique that is easily learned and may be useful if tracheal intubation by direct laryngoscopy is impossible [1]. Lightwand tracheal intubation has been recommended in the difficult airway algorithm of the ASA as an intubation choice for patients with difficult intubation and effective ventilation by face mask or Laryngeal Mask Airway (LMA; nonemergency pathway) [3]. The failure rate of lightwand tracheal intubation without a muscle relaxant is significantly higher than it is with a muscle relaxant [4]. Patients who are not first given a muscle relaxant undergo more intubation attempts, require greater intubation time, and experience a higher incidence of events during intubation than those who receive a muscle relaxant [4]. Tracheal intubation may be accomplished without muscle relaxants, but satisfactory conditions are not reliably obtained in all patients [5,6].

Remifentanil as part of an induction regimen provides good or excellent conditions for tracheal intubation without the need for muscle relaxants while attenuating the hemodynamic response to laryngoscopy [7]. Remifentanil also facilitates insertion of the LMA [8] and Cobra Perilaryngeal Airway (CobraPLA; Engineered Medical Systems, Inc., Indianapolis, IN, USA) [9]. The present study was designed to determine the most suitable effect-site concentration of remifentanil in providing successful lightwand tracheal intubation when given with a target-controlled infusion (TCI) of propofol at 4.0 μg/mL without neuromuscular blockade.

2. Materials and methods

After approval of the Institutional Review Board on Human Subjects Research and Ethics Committee of Hanyang University Guri Hospital and informed consent, ASA physical status 1 and 2 patients, aged 18-65 years, undergoing minor elective surgery, were considered for the study. Age, gender, weight, height, Mallampati class, mouth opening, and thyromental distance were recorded. Exclusion criteria included patients with cardiovascular, respiratory, hepatic, renal, or neuromuscular diseases; uncooperative patients; those with a history of gastroesophageal reflux or increased risk of aspiration; and those with coagulation disorders. Also excluded were patients with a history of difficult intubation or suspected difficult intubation, defined as a Mallampati class IV airway; retrognathia; restricted neck movements; or more than two criteria among the following: Mallampati class III airway, mouth opening less than 35 mm, or thyromental distance less than 65 mm. All of these parameters were measured by an experienced anesthesiologist.

In the operating room, routine monitors and a Bispectral Index sensor (BIS; Aspect Medical Systems, Norwood, MA, USA) were attached. Baseline values of mean arterial blood pressure (MAP), heart rate (HR), oxyhemoglobin saturation (SpO2), and BIS scores were recorded. These values were then measured at induction (loss of consciousness), intubation, and one minute after intubation. After each patient received 100% oxygen by face mask, anesthesia was induced by TCI propofol using the pharmacokinetic (PK) parameter set of Schnider et al [10], as included in the Orchestra Base Primea infusion device (Fresenius Kabi, Bad Homburg, Germany), and by setting the propofol target effect-site concentration to 4.0 μg/mL. Propofol effect-site concentrations were determined on the basis of an equilibration constant (Keo) of 0.456/min. Before administration of propofol, remifentanil was given by a TCI device to ensure a constant effect-site concentration. The Orchestra Base Primea infusion device, whose PK was the Minto et al model [11], which adjusts for age, weight, and gender, and has a Keo of 0.595-0.007× (age-40)/min, was used.

The dose of remifentanil given to each patient was determined by the response of the previously tested patient using a modified Dixon's up-and-down method (using 0.2 ng/mL as a step size) [12]. The first patient was tested at a target effect-site concentration of 4.0 ng/mL of remifentanil. If intubation was successful, the remifentanil effect-site concentration was decreased by 0.2 ng/mL; if it failed, the concentration was increased by 0.2 ng/mL.

During administration of propofol and remifentanil, patients were asked to open their eyes every 10 seconds. Failure to do so was taken as loss of consciousness, and was confirmed by testing the loss-of-eyelash reflex. BIS score, propofol effect-site concentration, and remifentanil concentration were checked at the same time. After the BIS score decreased below 60, the propofol effect-site concentration was greater than 4.0 μg/mL, and the remifentanil effect-site concentration reached a determined level, all patients underwent direct laryngoscopy without intubation by another anesthesiologist who was blinded to the previous measurements. Views were scored according to Cormack and Lehane criteria [13].

Lightwand tracheal intubation with the Surch-Lite (Aron Medical, St. Petersburg, FL, USA) was attempted by an anesthesiologist with more than 50 previous intubations; the lightwand with Surch-Lite was used after the BIS value was again below 60. All procedures were performed by the same anesthesiologist (CS). The patient's head and neck were placed in a neutral position during ambient light conditions, with the lightwand bent at a 90° angle. Endotracheal tubes with a 7.5 mm and 7.0 mm internal diameter for men and women, respectively, were used. Any intubation attempt that lasted more than two minutes or was associated with the appearance of cough, patient movement, peripheral SpO_2