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Original Contribution

Median effective concentration of remifentanil in target controlled infusion for smooth tracheal extubation during emergence from general anesthesia in elderly patients☆,☆☆

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Abstract

Study objective: To determine the median effective concentration (EC_{50}) of remifentanil during targeted-controlled infusion for smooth tracheal extubation during emergence from total intravenous anesthesia in elderly patients.

Design: Prospective, Dixon up-and-down method.

Setting: Postoperative emergence.

Patients: Twenty-four American Society of Anesthesiologists grade I-II female elderly patients undergoing elective jaw cyst surgery.

Interventions: The EC_{50} of remifentanil for smooth emergence was calculated by the Dixon up-and-down method.

Measurements: The EC_{50} and 95% confidence intervals were analyzed by probit analysis using logistic regression. Vital signs (mean arterial pressure, heart rate, oxygen saturation, and end-tidal carbon dioxide partial pressure), postanesthesia recovery score, visual analogue pain scale, and adverse effects were monitored. Mean arterial pressure and heart rate were compared between patients with smooth extubation vs those with failed smooth extubation.

Main results: The Dixon up-and-down method showed that the EC_{50} of remifentanil for smooth tracheal extubation during emergency from anesthesia was 0.94 ng/mL in female elderly patients. The probit analysis showed that the EC_{50} of remifentanil was 0.99 ng/mL (95% confidence interval, 0.52-1.51 ng/mL). Heart rate and mean arterial pressure were significantly lower in patients with smooth extubation as compared with those with failed smooth extubation at 0 minute (at extubation) as well as 1 and 5 minutes after extubation ($P < .05$).

Conclusions: Target infusion of remifentanil at 0.94 ng/mL could effectively inhibit tracheal extubation–related cough response and cardiovascular responses in 50% of the female elderly patients without delaying recovery from anesthesia, which could ensure smooth tracheal extubation during emergence from anesthesia.

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1. Introduction

Tracheal extubation during emergence from anesthesia may induce cough and result in a series of adverse effects including laryngismus, hypertension, tachycardia, intracranial hypertension, intraabdominal high pressure, and myocardial ischemia [1,2]. Therefore, preventing and controlling cough response during tracheal extubation are very important for anesthetists to ensure smooth emergence from anesthesia. This is of particular importance in elderly patients who generally have a poor stress response and attenuated self-control of the autonomic nervous system. These patients have strong responses to tracheal extubation during emergence from anesthesia. Elderly patients who receive surgical treatment for jaw cysts are at particular risk for complications given the change in the anatomical structure of the airway, wound dressing, bleeding, and secretions [3–5].

Various methods have been applied to decrease the incidence of cough during tracheal extubation including tracheal extubation while the patient is in the deep anesthesia state; administration of lidocaine; and infusion of various drugs such as dexmedetomidine, vasodilators, and short-acting opioids [6–8]. Remifentanil, a potential short-acting μ-receptor agonist that is metabolized independently of renal and liver functions, has been effectively used as an analgesic, sedative, and antitussive [9] and could decrease the adverse events from tracheal extubation during emergence from total intravenous anesthesia (TIVA) [8].

The functions of the important organs are generally decreased in elderly patients, which should be considered when using anesthetics. Compared with traditional infusion, target-controlled infusion (TCI) could provide more accurate and stable blood concentration of the drugs to help the patients recover from general anesthesia [10]. Several studies suggested that TIVA with propofol-remifentanil could effectively reduce the tracheal extubation–related cough response and provide more stable emergence from anesthesia than inhalation of sevoflurane [8].

The objective of this study was to determine the median effective concentration (EC_{50}) of remifentanil used during TCI for smooth tracheal extubation during emergence from anesthesia in elderly patients.

2. Materials and methods

2.1. Patients

This was a prospective study of 24 female patients aged 65-85 years who underwent surgery for jaw cysts (American Society of Anesthesiologists I-II) under general anesthesia at the Affiliated Dental Hospital of Chongqing Medical University (China) between January 2013 and November 2013. Patients with severe cardiopulmonary diseases, New York Heart Association grade ≥ III, uncontrolled hypertension or diabetes, history of airway difficulties, long-term use of analgesics or sedatives, or addiction to opioids were excluded from this study.

This study was approved by the ethics committee of Chongqing Medical University. All patients provided a written informed consent.

2.2. Intubation procedure

The upper limb was punctured after the patient was transferred into the operating room, and multiple electrolytes (5 mL/kg) were infused within 30 minutes. Mask oxygen inhalation was performed. Electrocardiogram, blood pressure, oxygen saturation, and bispectral index were routinely monitored. Midazolam (0.05 mg/kg) was administered 30 minutes before the operation along with an intramuscular injection of atropine (0.5 mg). A TCI pump (CP-600TCI, Minto model, Silugao, Beijing) was used for anesthesia induction. Remifentanil and propofol were injected with target effect-site concentrations of 3 ng/mL and 2.5 μg/mL, respectively. After complete loss of consciousness, cisatracurium (0.15 mg/kg) was intravenously injected, and endotracheal intubation through the nose was performed. A Drager Fabius anesthesia machine was used to control breathing. End-tidal carbon dioxide partial pressure ($Petco_2$) was maintained at 35-40 mm Hg during the operation. The doses of propofol and remifentanil were monitored and maintained between 1.5 and 3.5 μg/mL and 1.5 and 4 ng/mL, respectively, to keep the blood pressure and heart rate (HR) at approximately 10%-20% of the baseline levels and bispectral index between 40 and 60. Before wound suturing, the target dose of remifentanil was adjusted to a predetermined level (eg, 1.0 ng/mL for the first patient) and maintained for at least 15 minutes until tracheal extubation to ensure stable effect compartment concentration and plasma concentration. Propofol infusion was stopped when the operation was over, and 2 mg/kg of tramadol was intravenously injected as an alternative analgesic; 0.02 mg/kg of neostigmine and 0.005 mg/kg of atropine were also administered as muscle-relaxant antagonists. Manual ventilation was used instead of mechanical ventilation until the patient opened her eyes to restore spontaneous frequency and tidal volume. Tracheal extubation was performed when the oxygen saturation (Spo_2) was ≥95% and $Petco_2$ was 35-45 mm Hg. The patient was transferred to the recovery room after a 5-minute observation.

2.3. Assessments

To evaluate the smoothness of tracheal extubation during emergence from anesthesia, a 5-point scale was used to access the coughing response at the time of tracheal extubation: (1) no cough or muscle rigidity, (2) mild cough (1-2 times) but easy extubation, (3) moderate cough (3-4 times), (4) severe cough (5-10 times) and muscle rigidity, and (5) dysphoria and tracheal extubation could not be performed (cough for more than 10 times or accompanied with bronchospasm) [6].