ORIGINAL RESEARCH

Transcutaneous electrical acupoint stimulation before induction of anesthesia reduces sufentanil-induced cough: a randomized, controlled trial

Jun-Jie Xie, Yun-Chang Mo, Jun-Kai Wang, Li-Li Yang, Hai-Juan He, Jun-Lu Wang

Abstract

Background: Sufentanil-induced cough is a common side effect during the induction of general anesthesia. This study sought to determine the inhibitory effect of TEAS (transcutaneous electrical acupoint stimulation) on the incidence of sufentanil-induced cough.

Methods: A total of 339 patients were recruited of which 300 patients were enrolled and randomly allocated into five groups (n = 60): Patients did not receive TEAS in the control group (C group); patients received 2 Hz TEAS at LI4/PC6 (Hegu/Neiguan) in the 2A group; patients received 100 Hz TEAS at LI4/PC6 in the 100A group; patients received 2 Hz TEAS at ST36/SP6 (Zusanli/Sanyinjiao) in the 2B group; and patients received 100 Hz TEAS at ST36/SP6 in the 100B group. With the exception of the C group, all groups received TEAS for 30 minutes before induction. 0.5 μg/kg of IV sufentanil was given over 2 seconds, and the occurrence of cough was observed and recorded for 1 minute. The severity of cough was graded as mild (1-2 coughs), moderate (3-5 coughs), and severe (> 5 coughs). The mean arterial pressure (MAP) and heart rate (HR) before (T0) and 1 minute after (T1) sufentanil injection were recorded.

Results: The incidence of sufentanil-induced cough in C group, 2A group, 2B group, 100A group and 100B group were 37%, 27%, 27%, 12% and 13%, respectively. Compared with the C group, the incidence of cough in the 100A group and the 100B group were significantly lower (P < 0.05). The MAP and HR between the five groups were not statistically different.

Conclusion: The administration of 100 Hz TEAS for 30 minutes before sufentanil injection can effectively reduce the incidence of sufentanil-induced cough during the induction of general anesthesia.

Keywords
Sufentanil; Cough; TEAS; General anesthesia

1. Introduction

Sufentanil is an opioid anesthetic, is widely used in clinical anesthesia due to its strong analgesic effect, rapid-onset, and stable cardiovascular effects. However, intravenous (IV) sufentanil injection can evoke a cough reflex, which may increase the risk of anesthesia. A previous report [1] showed that the incidence of sufentanil-induced cough is 28% in Asian patients. Although sufentanil-induced cough is usually transient and benign, it may result in serious complications in patients with ocular trauma, pneumothorax, a reactive/difficult airway, aortic dissection, or patients undergoing neurosurgery [2]. During the COVID-19 pandemic, coughing during induction increases the risk of transmission of the virus to the anesthesiologist [3].

Previous studies have reported various approaches to suppress sufentanil-induced cough during anesthetic induction. These approaches have included pre-induction with IV lidocaine, ephedrine [4], dexamethasone [5], ketamine [6], clonidine [7], dexmedetomidine [1], and β-receptor blocker inhalation [8]. However, due to the side effects of these drugs, these methods are not widely used.

Transcutaneous Electrical Acupoint Stimulation (TEAS) has an analgesic effect, reduces the perioperative inflammatory response, and promotes immune function and oxygenation [9]. TEAS has been proven to have a significant effect on the treatment of lung diseases, such as COPD and asthma [10, 11], however TEAS has not been used to prevent sufentanil-induced cough. We therefore sought to determine whether patients receiving TEAS before anesthetic induction can effectively reduce sufentanil-induced cough in a randomized, controlled clinical trial.
2. Materials and methods

This study was conducted after approval from the ethics committee of the First Affiliated Hospital of Wenzhou Medical University (2016-142) (Wenzhou, China) and registered at the Chinese Clinical Trial Registry (ChiCTR-INR-16008759). Written informed consent was obtained from all patients.

The inclusion criteria included age 20 through 75 years, with an ASA physical status of I or II, undergoing elective surgical procedures under general anesthesia.

The exclusion criteria were as follows: any incision or surgical scar in an acupoint; infection in an acupoint; nerve injury in the upper or lower limbs; a history of spinal surgery; allergic reaction to drugs used in the study; sinus bradycardia; severe neurological disease (intracranial hypertension, cerebral hernia, cerebral tumor, cerebral aneurysm); severe respiratory disease (asthma, pneumothorax, chronic obstructive pulmonary disease, bronchial hyperresponsiveness); smoking; severe cardiovascular disease (myocardial infarction, aortic dissection); addiction to anaesthetic or recent history of opioid use; upper respiratory tract infection in the previous 2 weeks; biliary tract surgery; or treatment with angiotensin-converting-enzyme inhibitors (ACE-inhibitors).

This study was conducted from August 2016 to July 2019 at the First Affiliated Hospital of Wenzhou Medical University. 300 patients were randomly divided into five groups (n=60): Patients did not receive TEAS in the control group (C group); patients received 2 Hz TEAS at the bilateral LI4/PC6 in the 2A group; patients received 100 Hz TEAS at the bilateral LI4/PC6 in the 100A group; patients received 2 Hz TEAS at the bilateral ST36/SP6 in the 2B group; patients received 100 Hz TEAS at the bilateral ST36/SP6 in the 100B group. The locations of all the acupoints are shown in Fig. 1.

Except for the C group, other groups received TEAS for 30 minutes before induction of anesthesia. Venous access was established using a 22 G cannula on the dorsum of the non-dominant hand before entering the operating room. No medication other than crystalloids were given. Upon arrival in the operating room, non-invasive blood pressure recordings, oxygen saturation values, and electrocardiography were recorded. The anesthesia induction sequence was started with intravenous sufentanil (0.5 μg/kg) over two seconds. An independent observer recorded the occurrence of cough after sufentanil administration after 1 minute. The severity of cough was graded as mild (1-2 coughs), moderate (3-5 coughs), and severe (>5 coughs). After this observation period, propofol (2 mg/kg) and rocuronium (1 mg/kg) were given and endotracheal intubation was performed. Mean Arterial Pressure (MAP) and Heart Rate (HR) before (T0) and 1 minute after (T1) sufentanil injection were recorded.

During the time from sufentanil administration to successful endotracheal intubation, an oxygen mask was applied if the blood oxygen saturation was < 90%; norepinephrine was given if the systolic blood pressure (SBP) was < 90 mmHg or the diastolic blood pressure (DBP) was < 60 mmHg; and atropine 0.5 mg was given if the HR was < 50/min.

2.1 Statistical analysis

The required sample size was estimated based on a 30% reported incidence of sufentanil-induced cough, and an assumption that TEAS would reduce the incidence of cough to 8%, according to a pilot study. With $\alpha = 0.05$ and $\beta = 0.20$, a minimum of 60 patients per group were required.

We used a randomization table to randomize patients. The random numbers were divided by 5; the remainder of the division sum (0, 1, 2, 3, 4) was used to decide the allocation to each of the 5 groups.

SPSS 20.0 software was used for statistical analyses. Data were expressed as mean ± standard deviation, and ANOVA was used to assess the differences between the five groups. The categorical data were compared using the chi-square test. $P < 0.05$ was considered statistically significant.

3. Result

A total of 339 patients were recruited from August 2016 to July 2019, 39 patients were removed because they did not meet the inclusion criteria, and 300 patients were enrolled (5 patients with a history of asthma, 19 patients were smokers, and 15...
FIGURE 2. Number of patients included and excluded.

TABLE 1. Characteristics of the patients.

<table>
<thead>
<tr>
<th></th>
<th>C group</th>
<th>2A group</th>
<th>2B group</th>
<th>100A group</th>
<th>100B group</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, years</td>
<td>47 (13)</td>
<td>47 (14)</td>
<td>48 (13)</td>
<td>47 (12)</td>
<td>48 (12)</td>
<td>0.603</td>
</tr>
<tr>
<td>Sex, M/F</td>
<td>17/43</td>
<td>13/47</td>
<td>16/44</td>
<td>19/41</td>
<td>15/45</td>
<td>0.790</td>
</tr>
<tr>
<td>Weight, kg</td>
<td>62 (11)</td>
<td>61 (11)</td>
<td>62 (11)</td>
<td>61 (12)</td>
<td>61 (10)</td>
<td>0.589</td>
</tr>
<tr>
<td>Height, cm</td>
<td>161 (7)</td>
<td>162 (7)</td>
<td>163 (7)</td>
<td>161 (8)</td>
<td>161 (7)</td>
<td>0.273</td>
</tr>
<tr>
<td>ASA 1/2</td>
<td>23/37</td>
<td>26/34</td>
<td>21/39</td>
<td>20/40</td>
<td>19/41</td>
<td>0.696</td>
</tr>
</tbody>
</table>

Values are the mean (SD). The Characteristics of patients did not differ significantly in the 5 groups (P > 0.05).

patients were taking an ACE inhibitor) (Fig. 2).

The patient characteristics (age, weight, sex) in the 5 groups were not statistically different (Table 1). The incidence of sufentanil-induced cough in the C group, 2A group, 2B group, 100A group and 100B group were 37%, 27%, 27%, 12% and 13%, respectively. Compared with the C group, the incidence of cough in the 100A group and 100B group were significantly lower (P < 0.05) (Table 2). However, the severity of cough was not statistically different amongst the groups using ANOVA testing (Table 2). The MAP and HR between the five groups were not statistically different (Table 3). After the injection of sufentanil, none of the patients developed decreased blood oxygen saturation (SpO2 < 90%), hypotension, apnea, nausea, vomiting, or any other adverse reactions.

4. Discussion

Our study revealed that using TEAS at a frequency of 100 Hz for 30 min at the bilateral LI4/PC6 and ST36/SP6 acupoints before induction of general anesthesia can significantly reduce the incidence of sufentanil-induced cough.

Sufentanil is a synthetic opioid drug that is widely used for the rapid induction of anesthesia. However, IV injection of sufentanil can evoke coughing, which increases the risks associated with anesthesia. Li et al. [12] found that the use of
In our study, we found that patients who received 100 Hz TEAS for 30 min before sufentanil injection can effectively reduce the incidence of sufentanil-induced cough during the induction of general anesthesia.

5. Conclusions

Patients receiving 100 Hz TEAS for 30 min before sufentanil injection can effectively reduce the incidence of sufentanil-induced cough during the induction of general anesthesia.

AUTHOR CONTRIBUTIONS

Junjie Xie and Junlu Wang designed the study. Junkai Wang, Lili Yang, and Haijuan He collected the data. Junjie Xie and Yunchang Mo analyzed the data. Junjie Xie analyzed the results and drafted the manuscript.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

This study was conducted after approval from the ethics committee of the First Affiliated Hospital of Wenzhou Medical University (2016-142) (Wenzhou, China) and registered at the Chinese Clinical Trial Registry (ChiCTR-INR-16008759). Written informed consent was obtained from all patients.
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CONFLICT OF INTEREST
All authors declare that they have no conflict of interests.

CONSENT FOR PUBLICATION
All authors have given full consent for publication.

DATA AVAILABILITY
The data used to support the findings of this study are available from the corresponding author upon request.

REFERENCES