

## Original Research Article

# Combined sevoflurane/sufentanil anesthesia for removal of tracheal foreign bodies in pediatric surgery, and its effect on hemodynamics

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Sent for review: 17 June 2023

Revised accepted: 25 August 2023

### Abstract

**Purpose:** To determine the efficacy of sevoflurane + sufentanil combination anesthesia in pediatric surgery for removal of tracheal foreign bodies, and its effect on hemodynamics.

**Methods:** A total of 128 children with airway foreign bodies were assigned to control and study groups, each with 64 children. The control patients received slow intravenous injection of propofol (3 mg/kg). The study group was given 5 % sevoflurane and a slow intravenous injection of sufentanil (0.3 µg/kg). Hemodynamic parameters (diastolic blood pressure, systolic blood pressure and heart rate) were recorded before induction of anesthesia, at the time of intubation, during placement of a rigid bronchoscope (when the lens was placed), during removal of foreign bodies, and when extubating. Complications in children in the two groups after the removal of airway foreign body were recorded.

**Results:** At the times of intubation and extubation, blood pressure and heart rate were significantly increased in both groups, but appreciably lower values were seen in study group. The major complications in pediatric airway foreign body removal in two groups were vomiting, bronchospasm and holding of breath.

**Conclusion:** In children with airway extraction, sevoflurane, in combination with sufentanil produced better anesthetic effect and less impact on hemodynamics than propofol. Moreover, the children woke up faster and had fewer complications. The combined anesthesia is safe and reliable. However, the clinical application of this combined anesthesia requires larger-sample clinical studies.

**Keywords:** Sevoflurane, Sufentanil, Pediatric surgery, Tracheal foreign bodies, Hemodynamics

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## INTRODUCTION

Airway foreign bodies generally refer to throat, trachea, and bronchial external bodies which keep patients awake, with sudden inability to speak. Airway foreign body causes cough, as well as symptoms of distress and suffocation.

After opening the airway, there is resistance to breathing air [1]. Foreign body in airway is a common emergency in pediatrics. As the airway of children is relatively narrow, the cough reflex is incomplete, which makes the situation more complicated, and the prognosis is very different due to the nature, size, condition and course of

the disease [2]. Due to different dietary habits in China, the incidence of airway foreign bodies is relatively high. According to statistics, more than 300 children with airway foreign bodies are admitted to our hospitals each year, with serious impact on the children and their families [3]. The current methods used for removing children's airway foreign bodies are mostly surgical, but because the patients are young, the degree of surgical cooperation is lower, and the children need to be able to wake up in time in order to prevent adverse reactions, e.g., hypoxia. Therefore, the choice of an appropriate anesthesia method is important in achieving a safe operation [4].

Sevoflurane is a new type of inhaled anesthetic, but several studies have shown that adverse stress response is not effectively inhibited during surgery, in addition to hemodynamic instability [5,6]. Sufentanil is a potent opioid analgesic with strong analgesic effect and short half-life [7]. Studies have found that combined use of sevoflurane and sufentanil provides good synergistic effect, with rapid onset and strong controllability [8]. In this study, sevoflurane and sufentanil combination anesthesia was applied in the surgical removal of foreign bodies in children, and its effect on hemodynamics was determined.

## METHODS

### Patients

A total of 128 children with airway foreign body admitted to the General Hospital of Western Theatre Command, Chengdu, China from June 2017 to February 2019 were randomly assigned to control and study groups, each with 64 children. The subjects included were those with evidence of CT confirmation of the presence of foreign bodies in the airway. This research received approval from the ethical authority of the General Hospital of Western Theatre Command, Chengdu (approval no. XDPHCH002) and followed international guidelines for human studies. Patients and their families signed and submitted informed consent forms. Children who had cardiac dysfunction, lung disease, or a history of drug allergies, were not included. Patients in control group comprised 39 boys and 25 girls (mean age =  $1.67 \pm 0.88$  years and mean body mass index (BMI) =  $19.87 \pm 3.46$  kg/m<sup>2</sup>). There were 37 males and 27 females in the study group, with a mean age of  $1.75 \pm 0.92$  years, and a BMI of  $19.52 \pm 4.47$  kg/m<sup>2</sup>. There were no significant differences in the basic data between the control and study groups ( $p > 0.05$ ).

### Instruments and reagents

Vital signs monitor was purchased from Nanjing Beideng Medical Co. Ltd. (S-600). Anesthesia machine was purchased from Beijing Mairun Medical Medical Devices Co. Ltd. (approval no. WATO EX-55/65). Atropine was bought from Zhejiang Ruixin Pharmaceutical Co. Ltd. (approval no. 33170465, specification: 1 mL: 5 mg). Propofol was supplied by AstraZeneca UK Limited (approval no. 20170535, specification: 50 mL: 500 mg). Sufentanil was obtained from Yichang Renfu Pharmaceutical Co. Ltd. (approval no. 20174172, Specification: 250 µg/5 mL).

### Procedures

All children were fasted before surgery, and atropine (0.02 mg/kg) was injected into the gluteus maximus 30 min prior to operation. Immediately the patients entered the theatre, the vital signs monitor was connected, venous access was established, and the electrocardiogram, heart rate, and blood pressure were routinely monitored. A suitable mask was selected for oxygen inhalation. Under anesthesia, the muscle was intubated and the oxygen flow rate was maintained at 4 L/min. Anesthesia induction was performed using 5 % sevoflurane. The control patients received slow intravenous administration of propofol (3 µg/g), while the study group was given a slow intravenous injection of sufentanil (0.3 µg/kg).

After each child lost consciousness as confirmed by the disappearance of eyelash reflex, and having established stable breathing, airway microscopy was performed using a hard bronchoscope. The foreign body was removed and the sevoflurane flow was stopped after careful examination to ascertain absence of residual foreign matter. During the anesthesia, the oral and nasal secretions of the child were promptly removed through suction.

The stable child was transferred to the anesthesia recovery room and monitored continuously until consciousness was recovered and the oxygen saturation rose above 95 %.

### Evaluation of parameters/indices

The time of extubation, respiratory recovery time, and wake-up time were compared between both groups. Moreover, the degree of agitation was evaluated in the two groups according to the sedation-excitement score, and a quiet state was considered as having *no agitation* throughout the procedure. Slight agitation when sucking and

other stimuli were considered as *mild agitation*. However, if the child struggled violently and had to be restrained, this was taken as *severe agitation*.

Changes in hemodynamic parameters (diastolic blood pressure, systolic blood pressure, and heart rate) were measured before anesthesia induction, during intubation, when placing a rigid bronchoscope, during removal of foreign bodies, and when extubating.

Complications in children in the two groups after the removal of airway foreign body were recorded.

### Statistics

Data were compared using an independent sample *t*-test, while count data were compared using  $\chi^2$  test. Comparison of ranking data was done with Ridit test. Differences were considered statistically significant at  $p < 0.05$ . All statistical analyses were done with SPSS 22.0 software package for statistical data analysis.

## RESULTS

### Changes in postoperative extubation, respiratory recovery, and wake-up times

Compared with control patients, the extubation time, respiratory recovery time, and time taken

for recovery were significantly shorter in study group ( $p < 0.01$ ; Table 1).

**Table 1:** Changes in postoperative extubation time, respiratory recovery time, and recovery time (n = 64)

Group	Extubation time (min)	Respiratory recovery time (min)	Wake-up time (min)
Study	9.05±3.67	7.84±2.75	8.58±2.19
Control	7.01±3.26	5.46±2.33	6.15±1.86
<i>t</i>	3.325	5.283	6.766
<i>P</i> -value	0.001	<0.001	<0.001

### Degrees of agitation

Results show significantly higher agitation in study group than in control patients, with significantly lower incidence of moderate agitation in the control group ( $p < 0.01$ ; Table 2).

### Hemodynamic parameters

Levels of hemodynamic parameters were similar in both groups before induction and during removal of foreign bodies ( $p > 0.05$ ). At the times of intubation and extubation, the blood pressure and heart rate were significantly increased in both groups but were appreciably lower in study group. These results are shown in Table 3.

**Table 2:** Comparison of degree of agitation (n = 64)

Group	Calmness	Mild agitation	Moderate agitation	Severe agitation
Study	25 (39.06)	22 (34.38)	14 (21.88)	3 (4.69)
Control	10 (15.63)	21 (32.81)	18 (28.13)	15 (23.44)
$\chi^2$			14.952	
<i>P</i> -value			0.002	

**Table 3:** Hemodynamic parameters in children in the 2 groups (n = 64)

Group	Time	Diastolic blood pressure (mmHg)	Systolic blood pressure (mmHg)	Heart rate (n/min)
Control	Before induction	79.21±8.17	126.77±11.15	74.46±7.27
	When intubating	95.31±7.35 <sup>a</sup>	154.77±15.29 <sup>a</sup>	91.52±6.24 <sup>a</sup>
	When setting the mirror	73.42±5.37	128.75±10.35	67.77±5.38
	When taking foreign objects	72.26±5.33	118.86±10.47	72.25±7.27
	When extubating	92.33±7.29 <sup>a</sup>	141.57±15.54 <sup>a</sup>	88.52±7.12 <sup>a</sup>
Study	Before induction	80.41±7.74	129.35±9.51	73.35±6.68
	When intubating	83.14±7.33 <sup>ab</sup>	132.83±13.69 <sup>ab</sup>	79.68±6.48 <sup>b</sup>
	When setting the mirror	75.25±4.46	124.65±9.83	68.39±5.67
	When removing foreign objects	71.35±3.85	116.86±8.97	72.73±6.78
	When extubating	78.39±5.87 <sup>ac</sup>	129.77±9.34 <sup>c</sup>	79.68±4.56 <sup>c</sup>

<sup>a</sup> $P < 0.05$ , compared with the control group; <sup>b</sup> $p < 0.05$ , compared with the control group at the time of intubation; <sup>c</sup> $p < 0.05$ , compared with the control group at the time of extubation

## Incidence of postoperative complications

The main postoperative complications of pediatric airway foreign body removal were vomiting, bronchospasm and holding of breath. The incidence of bronchospasm was similar in both groups, while the study group had vomiting. However, the incidence of breathholding was significantly lower in the study group ( $p < 0.05$ ). These data are presented in Table 4.

**Table 4:** Comparison of complications between the two groups after operation (n = 64)

Group	Vomiting	Bronchospasm	Breath
Control	8 (12.50)	1 (1.56)	9 (14.06)
Study	2 (3.13)	0 (0.00)	2 (3.13)
<i>t</i>	3.905	1.008	4.873
<i>P</i> -value	0.048	0.315	0.027

## DISCUSSION

Foreign body in children's airway is one of the acute and serious problems in pediatrics. The operation time is short, but the child's agitation makes the foreign body difficult to remove. Therefore, the search for anesthetic drugs with the advantages of rapid onset, rapid recovery, and hemodynamic stability has become a clinically important issue [9]. Since the airway subjected to surgery and anesthesia is unchanged when the airway foreign body is removed, the child will have different degrees of hypoxia. Therefore, the child needs to be quickly and smoothly induced to a sufficient depth of anesthesia without aggravating hypoxia.

Sevoflurane, also known as fluoromethyl-isopropyl ether, is a new inhalation anesthetic developed after halothane and isoflurane. It is characterized by fast induction of anesthesia, absence of tissue toxicity, rapid recovery, low stimulation of the respiratory tract, and absence of bronchospasm [10]. This study has shown that sevoflurane is especially suitable for inhalation induction in children, but the incidence of unintentional limb movement with sevoflurane alone is higher [11]. Sufentanil is an opioid analgesic and a thienyl derivative of fentanyl. It has high lipophilicity, with high permeability to the blood-brain barrier, long half-life, and a strong analgesic effect, and it lasts for a longer period, about twice that of fentanyl [12]. Lejus *et al* reported that sufentanil significantly reduced the incidence of unconscious limb movement during labor [13]. It has been reported that sevoflurane +sufentanil combined anesthesia exerted a synergistic effect, quickly and effectively adjusted the depth of anesthesia, maintained spontaneous breathing, and significantly reduced the

cardiovascular response caused by bronchoscopy implant stimulation [14].

To prevent complications such as cough, breath-holding, and irritability, sufficient anesthesia depth must be maintained during pediatric airway resection, but this may cause a delay in the recovery of the child. This study found that compared with the control group, the extubation time, respiratory recovery time, and recovery time of the study group were significantly shorter. Infarction incidence was significantly higher in study group, while the incidence of moderate agitation was significantly lower when compared to the control subjects. There was no significant difference in the incidence of bronchospasm between the two groups. The incidence of vomiting and breathholding was significantly lower in the study group than in control subjects. These data suggest that the combined use of sevoflurane and sufentanil anesthesia was beneficial for the removal of airway foreign bodies in the children. The children woke up and recovered quickly, with a low degree of complications, and the combined anesthesia was highly safe.

When anesthesia induces tracheal intubation, placement of laryngoscope and tracheal intubation may cause increases in reflex blood pressure and heart rate in the child. A study by Hu *et al* showed that changes in blood pressure have an important relationship with changes in cardiac output and cardiac index, due to the dual effects of peripheral vasodilation and direct heart transplantation [5]. Abnormal stimulation may cause changes in central nervous system function, and changes in autonomic nervous system function that regulates blood pressure and heart rate changes are one of the important measures for reducing abnormal stress hazards during anesthesia and maintenance of patient safety [16].

In this study, hemodynamics was similar in both groups, before induction, during implantation, and removal of foreign bodies. At the time of intubation and extubation, the blood pressure and heart rate in both groups were significantly increased, with significantly lower values in the study group. This suggests that sevoflurane + sufentanil anesthesia had little effect on hemodynamics in children undergoing airway extraction.

### Limitations of this study

The source of samples was single. Therefore, there is need to expand the number and sources of samples in subsequent studies.

## CONCLUSION

In pediatric airway extraction, combined sevoflurane/sufentanil anesthesia is better than propofol. The impact on hemodynamics is smaller. Children wake up quickly and complications are low. However, the clinical application of this technique requires larger-sample clinical studies for validation of the findings of this study.

## DECLARATIONS

### Acknowledgements

None provided.

### Funding

None provided.

### Ethical approval

Ethical approval was obtained for this work from the Ethical Authority of the General Hospital of Western Theatre Command, Chengdu (approval no. XDPHCH002).

### Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

### Conflict of Interest

No conflict of interest associated with this work.

### Contribution of Authors

We declare that this work was performed by the authors named in this article, and all liabilities pertaining to claims relating to the content of this article will be borne by the authors. Haiyang Wang designed the study, supervised the data collection, and analyzed the data. Huaqu Gong interpreted the data and prepared the manuscript for publication. Tingting Liu and Lirong Duan supervised the data collection, analyzed the data and reviewed the draft of the manuscript.

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