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Original Research Article

Evaluation of propofol and remifentanil combination for controlled hypotension during anesthesia in pediatric nasal endoscopic surgery

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Abstract

Purpose: *To investigate the safety and efficacy of propofol in combination with remifentanil for controlled hypotension during pediatric nasal endoscopic surgery.*
Methods: *The study involved 30 patients who underwent controlled hypotension measures with remifentanil during the operation (study group), and 30 patients who did not receive controlled hypotension measures (control group). Various parameters including vital signs, operation time, intraoperative bleeding, surgical field quality, anesthesia quality, postoperative recovery time, adverse reaction rate, pain scores, and serum C-reactive protein levels were compared between the two groups.*
Results: *The results revealed a significant decrease in mean arterial pressure and heart rate in the study group during the operation compared to control group. Moreover, study group exhibited improved operation time, reduced intraoperative bleeding, and better surgical field quality compared to control group. Pain scores and serum C-reactive protein levels were also lower in the study group. However, there were no significant differences in recovery time, anesthesia quality, postoperative adverse reaction rate, or cognitive function between the two groups.*
Conclusion: *Propofol in combination with remifentanil for controlled hypotension is a safe and effective anesthesia approach for pediatric nasal endoscopic surgery. Future studies will require larger sample size from different study centers to improve the robustness of the findings of this study.*

Keywords: *Children, Nasal endoscopy, Adenoidectomy, Snoring, General anesthesia, Propofol, Remifentanil, Controlled hypotension*

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INTRODUCTION

Snoring is a common ear, nose, and throat disorder in clinical practice, with a high incidence rate among children. It is primarily caused by adenoidal hypertrophy in the nasopharynx, leading to nasal congestion and snoring after children fall asleep at night. In severe cases, hypoventilation and hypoxia reactions may occur, posing significant harm to patients' health [1-3]. Surgical treatment, particularly adenoidectomy, is recommended for children with snoring. By removing the hypertrophic adenoids, adenoidectomy alleviates nasal congestion and

hypoventilation that occur during sleep at night [4-6]. Nasal endoscopic adenoidectomy has become the preferred treatment method for snoring in children due to advancements in nasal endoscope technology. It is considered both effective and safe [7,8].

Anesthetic treatment is required during nasal endoscopic adenoidectomy to ensure successful completion of the procedure [9], and propofol general anesthesia is the most commonly used anesthesia protocol for nasal endoscopic surgery due to its effectiveness in maintaining anesthesia depth. However, because of the specific location of nasal endoscopic surgery and the limited surgical field, blood leakage is common, and this reduces the surgical field's definition necessitating discontinuation of the procedure. To address this issue, controlled hypotension measures are proposed to improve the surgical field's quality. Remifentanil, an opioid receptor agonist, reduces blood pressure and minimizes blood leakage in the surgical field. Currently, there are no previous studies investigating the effects of controlled hypotensive measures and remifentanil during propofol general anesthesia in children undergoing nasal endoscopic surgery.

This study was aimed at investigating the effects of controlled hypotensive measures with remifentanil during propofol general anesthesia in children undergoing nasal endoscopic surgery.

METHODS

General data

This was a retrospective analysis and a total of 60 snoring children between January 2020 and December 2022 were enrolled and randomly assigned to two groups; control and study groups. Control group consisted of 18 males and 12 females, aged between 6 and 12 years, with a mean age of 9.33 ± 2.14 years. The study group comprised of 16 males and 14 females, aged between 6 and 12 years, with a mean age of 9.17 ± 2.26 years. Control group comprised of 30 snoring children who did not receive controlled hypotensive measures with remifentanil during the operation. Study group consisted of 30 snoring children who received propofol general anesthesia during nasal endoscopic adenoidectomy. Clinical data of both groups were analyzed retrospectively. Comparative analysis of gender, age, and other baseline characteristics between the two groups were non-significant ($p > 0.05$) indicating homogeneity of the overall data. This study was performed in comformity with the Declaration of Helsinki [10] was approved by the ethics committee of PLA General Hospital (approval no. S2020-006-02) and signed written informed consents were obtained from the parents and/or guardians.

Inclusion criteria

Clinical diagnosis of snoring attributed to adenoid hypertrophy, patients who underwent endoscopic-assisted transoral adenoidectomy under propofol general anesthesia, aged between 6 and 14 years, with written informed consent for the operative plan obtained from parents of the children prior to the procedure. The study enrolled patients who met the criteria for endoscopic-assisted transoral adenoidectomy, and their complete medical records were collected for analysis.

Exclusion criteria

Individuals with concurrent otorhinolaryngologic conditions, severe infections, cardio-cerebrovascular disease, malignant tumors, coagulation dysfunction, and pre-existing mental or cognitive disorders were excluded.

Management protocol

Both groups received propofol general anesthesia during the operation. Anesthesia induction and intravenous administration comprised propofol at a dose of 2.0 mg/kg, midazolam at a dose of 0.1 mg/kg, sufentanil at a dose of 0.4 μg/kg, and vecuronium bromide at a dose of 1.0 mg/kg. After achieving muscular flaccidity, tracheal intubation was performed, and the trachea tube was connected to the anesthesia ventilator.

Propofol (0.12 to 0.15 mg/kg per minute) and remifentanil (0.05 to 0.25 μg/kg per minute) were administered intravenously to maintain anesthesia depth. Administration of propofol and remifentanil was stopped five minutes before the end of surgery. Patients were then transferred to the anesthesia recovery observation room and subsequently to the wards upon awakening.

In the study group, controlled hypotensive measures with remifentanil were implemented during the operation, while control group did not receive such measures. From the beginning of the operation, intravenous remifentanil infusion (0.25 μg/kg/min) was administered. The initial infusion rate was set at and was incrementally increased by 0.1 μg/kg/min every 2 mins until the patient's blood pressure reached the targeted range (average arterial pressure between 50 and 70 mmHg) throughout the operation.

Evaluation of parameters/indices

Vital signs

Vital signs (such as systolic arterial pressure and heart rate) of the patients in both groups were compared before intraoperative anesthesia induction (T0), 5 min after intubation (T1), 30 min after intubation (T2), and at the end of surgery (T3). Other variables compared between the two groups included operation time, intraoperative bleeding volume, surgical field quality scores, anesthesia quality (excellent and good rates), postoperative recovery time (including time for postoperative spontaneous respiration to recover, time for eye-opening, and time for instructional recovery), occurrence of postoperative adverse reactions, postoperative pain scores, postoperative serum C-reactive protein levels, and cognitive function scores before and after surgery.

Surgical field quality score

The quality of the surgical field was assessed based on the extent of blood seepage. Scores ranged from 0 to 5, with 0 indicating no blood seepage, 5 indicating uncontrollable bleeding, and higher scores indicating more severe blood seepage and poorer surgical field quality.

Rate of anesthesia

Rates of anesthesia were calculated as the sum of excellent and good rates. The evaluation criteria were classified as excellent (no pain, no tracheal reflex, calm expressions, and cooperation during intubation); good (slight pain and mild tracheal reflex during intubation, good muscle relaxation, slight changes in expressions, slight discomfort, and tolerability; poor (obvious pain and severe tracheal reflex during intubation, evident signs of pain, and forced interruption of intubation).

Pain score

Pain levels of resting and coughing patients were evaluated at 4, 8, and 12 h after the operation using the Visual Analog Scale (VAS), with scores ranging from 0 to 10. Higher scores indicated greater pain intensity.

Serum C-reactive protein

Blood samples were collected from the patient's elbow veins at 4, 8, and 12 hours after operation. The samples were centrifuged at 3000 revolutions per minute (rpm) for 10 mins. Subsequently, the serum obtained was utilized for the measurement of C-reactive protein levels through the immunoturbidimetry method.

Pain factor indicators

Prostaglandin E2 (PGE2) and interleukin-6 (IL-6) were measured in serum samples using an enzyme-linked immunosorbent assay.

Cognitive function score

The Minimum Mental State Examination Scale (MMSE) and the Montreal Cognitive Assessment Scale (MoCA) were used to assess patients' cognitive function before and after surgery. The total scores on both scales ranged from 0 to 30, with a cutoff value of 26. Scores below 26 indicated cognitive dysfunction and lower scores indicated poorer cognitive function.

Statistical analysis

Data was analyzed with Statistical Packages for Social Sciences (SPSS version 22.0 software). Chi-square test and t-test were employed for categorical and normally distributed continuous variables respectively. $P < 0.05$ was considered statistically significant.

RESULTS

Intraoperative symptoms

Compared with T0, the mean arterial pressure and heart rate of the study group at T1 and T2 were significantly decreased ($p < 0.05$), while the mean arterial pressure and heart rate of control group at T1 and T2 did not change significantly ($p > 0.05$). At T1 and T2, mean arterial pressure and heart rate in study group were significantly lower in control group ($p < 0.05$). At T3, there was no significant difference in mean arterial pressure and heart rate between the two groups ($p > 0.05$) (Table 1).

Operation time, intraoperative bleeding volume, and surgical field quality scores

Operation time in the study group was significantly shorter ($p < 0.05$), intraoperative bleeding volume and the surgical field quality scores were significantly lower ($p < 0.05$) compared to control group (Table 2).

Rates of anesthesia quality

There was no statistically significant difference in rates of anesthesia quality between study and control groups ($p > 0.05$) (Table 3).

Table 1: Intraoperative vital signs among the two groups (mean ± SD) (N = 30 in each group)

Group	Mean arterial pressure (mmHg)				Heart rate (times/min)			
	To	T1	T2	T3	To	T1	T2	T3
Control	76.42±5.73	76.98±6.09	76.56±6.02	76.17±6.14	71.24±3.58	71.45±3.39	71.31±3.47	71.08±3.87
Study	76.31±5.86	65.23±4.67#*	67.09±4.72#*	76.05±5.91	71.15±3.50	67.58±3.12#*	67.97±2.98#*	70.89±3.62

Note: A#*P* < 0.05 vs. preoperative values, **p* < 0.05 vs. control group

Table 2: Operation time, intraoperative blood loss and surgical subject pleasant rankings of the 2 groups (mean ± SD) (N = 30 in each group)

Group	Operation time (min)	Intraoperative bleeding volume (ml)	Surgical field quality score (points)
Control	72.14±10.61	34.65±9.57	3.29±0.78
Study	56.93±8.29*	21.08±6.20*	1.85±0.61*

**P* < 0.05 vs. control group

Table 3: Comparison of rates of anesthesia (N = 30 in each group)

Group	Excellent	Good	Poor	Excellent and good rates
Control	18(60.00 %)	11(36.67 %)	1(3.33 %)	29(96.67 %)
Study	16(53.33 %)	12(40.00 %)	2(6.67 %)	28(93.33 %)

Table 4: Postoperative anesthesia recuperation time of the 2 groups (mean ± SD)

Group	Recovery time of spontaneous respiration (min)	Eye-opening time (min)	Instruction recovery time (min)
Control	7.85±0.79	8.91±1.57	16.42±3.37
Study	7.89±0.82	9.04±1.45	16.85±3.60

Table 5: Occurrence of postoperative damaging reactions of the 2 groups (N = 30 in each group)

Group	Chill	Nausea	Respiratory depression	Agitation
Control group	0(0 %)	1(3.33 %)	1(3.33 %)	2(6.67 %)
Study group	2(3.33 %)	0(0 %)	2(6.67 %)	0(0 %)

Postoperative anesthesia recovery time

There was no statistically significant difference in recovery time for spontaneous respiration, eye-opening time, and orientation recovery time between the two groups ($p > 0.05$) (Table 4).

Incidence of postoperative adverse reactions

There was no significant difference in the incidence of adverse reactions between the two groups ($p > 0.05$) (Table 5).

Postoperative pain scores

At 4 h, 8 h, and 12 h after surgery, pain scores at resting and coughing states of patients in the study group were significantly lower compared to control group ($p < 0.05$) (Table 6).

Serum C-reactive protein levels after surgery

At 4, 8, and 12 h after surgery, serum C-reactive protein in study group was significantly lower compared to control group ($p < 0.05$) (Table 7).

Cognitive function scores

Post-surgery MMSE and MoCA scores of both groups did not show any significant difference compared to pre-surgery scores ($p > 0.05$). Also, there was no significant difference in MMSE and MoCA scores between the two groups ($p > 0.05$) (Table 8) before and after operation.

Table 6: Comparison of postoperative ache rankings among of 2 groups (mean ± SD) (N = 30 in each group)

Group	Pain score at 4 h after operation (points)		Pain score at 8 hours after operation (points)		Pain score at 12 h after operation (points)	
	Resting	***coughing***	***Resting***	***coughing***	***Resting***	***Coughing***
Control	2.47±0.70	2.53±0.82	2.96±0.91	3.10±1.03	3.07±0.82	3.29±0.86
Study	1.72±0.55*	1.89±0.62*	2.03±0.64*	2.17±0.70*	2.26±0.75*	2.41±0.79*

**P* < 0.05 vs. control group

Table 7: Serum C-reactive protein after operation (mean ± SD) (N = 30 in each group)

Group	C-reactive protein (mg/L)		
	4 h after operation	***8 h after operation***	***12 h after operation***
Control	8.97±1.65	7.93±1.50	6.80±1.54
Study	7.32±1.20*	6.41±1.24*	5.27±1.19*

*$P < 0.05$ vs. control group

Table 8: Cognitive characteristic ratings (mean ± SD)

Group	MMSE score (points)		MoCA score (points)	
	Before operation	***After surgery***	***Before operation***	***After surgery***
Control	26.51±2.92	26.17±2.61	24.73±3.15	24.39±2.96
Study	26.42±2.83	26.05±2.74	24.59±3.27	24.22±2.81

Table 9: Comparison of pain factor indices (mean ± SD) (N = 30 in each group)

Group	PGE_2 (pg/mL)		IL-6 (pg/mL)	
	Before operation	***After surgery***	***Before operation***	***After surgery***
Control	109.43±16.67	167.25±28.34#	95.62±10.38	139.70±18.16#
Study	108.72±16.82	136.91±23.56#*	95.07±10.43	117.49±16.92#*

#$P < 0.05$ vs. preoperative values; *$p < 0.05$ vs. control group.

Pain-related indices

Following surgery, average serum levels of PGE2 and IL-6 in both groups increased significantly compared to pre-operative levels ($p < 0.05$). Furthermore, study group exhibited significantly lower average serum PGE2 and IL-6 levels compared to control group ($p < 0.05$) (Table 9).

DISCUSSION

Children are at high risk of snoring during childhood, which is a common condition in the field of otorhinolaryngology. It is primarily caused by nocturnal sleep apnea and ventilation disorders resulting from narrowed or blocked upper respiratory tracts in children, also known as sleep apnea and hypopnea syndrome [11]. Snoring in children frequently results in recurrent hypoventilation and nighttime apnea, significantly impacting their sleep quality, daytime learning capabilities, and elevating the risk of cardiovascular disease. This, in turn, hinders their overall growth and development [12]. The primary contributor to snoring is adenoid hypertrophy, making adenoidectomy the preferred treatment. Through surgical removal of the adenoids, upper respiratory tract stenosis and obstruction in children is effectively alleviated, leading to improved nocturnal ventilation [13-15]. Due to limited space in the nasal cavity and the technical challenges involved, nasal endoscopy is increasingly utilized in adenoidectomy for snoring patients. Nasal endoscopes serve as optical devices that provide additional lighting to help healthcare providers visualize the nasal cavity during operation, enabling them to accurately resect the adenoids under proper illumination [16,17].

Endoscopic-assisted transoral adenoidectomy is an invasive procedure, and patients are prone to stress reactions during the operation. To ensure successful completion of the surgery, anesthesia is administered to patients to prevent interruptions caused by stress reactions. General anesthesia with tracheal intubation is the primary method used in nasal endoscopic surgery. Patients are sedated with intravenous infusion of general anesthesia drugs such as propofol to induce sleep [18-20]. However, due to the limited operating space in nasal endoscopic surgery and the highly vascularized nasal mucosa, intraoperative bleeding is common, which can compromise visibility of the surgical field. This may hinder the surgeon's ability to continue the operation. Although patients can undergo surgery in a calm state after anesthesia, clarity of the surgical field is crucial for achieving successful outcomes. Reducing blood pressure is the main strategy for minimizing intraoperative bleeding. Therefore, in addition to anesthesia, controlled hypotension is necessary during nasal endoscopic surgery to ensure a clear surgical field. Remifentanil is a commonly used as an adjunctive drug in clinical surgery to lower blood pressure. It is an opioid receptor agonist that rapidly dissolves in the blood after intravenous administration, leading to sedation. Remifentanil enhances vagal nerve excitability, inhibits sympathetic nerve excitability, and suppresses release of catecholamines. As a result, it slows down the heart rate and causes relaxation of vascular smooth muscles, thereby reducing blood pressure.

To investigate the effect of controlled hypotension with remifentanil in propofol general anesthesia protocol on children undergoing nasal endoscopic surgery, this study retrospectively analyzed two groups. A study group received controlled hypotensive measures with remifentanil, and control group (no hypotension control measures). The results showed that there was no significant difference in anesthesia quality rates, postoperative anesthesia recovery time, and incidence of adverse reactions between the two groups ($p > 0.05$). The MMSE and MoCA scores of both groups did not significantly change after surgery compared to before surgery ($p > 0.05$), indicating that the use of controlled hypotensive measures with remifentanil during propofol general anesthesia does not impact anesthesia effectiveness, safety, or increase the risk of cognitive impairment. Furthermore, the mean arterial pressure and heart rate of study group were significantly lower at T0 ($p < 0.05$), while there were no significant changes in mean arterial pressure and heart rate of control group at T1 and T2 compared to T0 ($p > 0.05$). Also, study group had significantly lower mean arterial pressure and heart rate, shorter operation time, lower intra-operative blood volume and surgical quality scores, lower pain scores, and serum C-reactive protein levels at 4, 8, and 12 h after surgery compared to control group ($p < 0.05$). Serum PGE2 and IL-6 levels in study group after surgery were also significantly lower on average ($p < 0.05$). These findings indicated that controlled hypotension treatment with remifentanil, in addition to intraoperative anesthesia, effectively reduces blood pressure and heart rate, minimizes blood leakage in the surgical field, ensures a clear surgical field, enables surgeons to complete the operation, reduces post-operative pain and inflammatory reactions, and provides better analgesic effects.

Limitations of this study

The sample size and the selection of subjects may limit the generalizability of the study, so study conclusions may not apply to wider populations. Also, the design and measurement tools employed in the study may present some challenges in interpreting the findings and accuracy of the results. In addition, there may be intervention factors that were not considered, which may have impacted the findings differently.

CONCLUSION

Combination of propofol and controlled hypotension with remifentanil in pediatric nasal endoscopic adenoidectomy effectively reduces intraoperative blood pressure and heart rate, minimizes bleeding in the surgical field, enhances surgical field quality, ensures the successful completion of the operation, improves postoperative analgesia, and preserves the efficacy of anesthesia without impacting postoperative cognitive function. Future studies will require a larger sample size from different study centers with a wider range of parameters to be investigated in order to improve the robustness of the findings of this study.

DECLARATIONS

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Ethical approval

None provided.

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

The authors declare that this work was done by the authors named in this article and all liabilities pertaining to claims relating to the content of this article will be borne by them. Siyao Li and Min Ye contributed equally to this work.

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