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A Study on the Application of Modified Positive Pressure Extubation Technique in General Anesthesia Recovery in the Post-Anesthesia Care Unit (PACU)

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Abstract

Objective: To investigate the application effect of the modified positive pressure extubation technique in general anesthesia recovery in the PACU. **Methods:** A total of 200 patients who underwent general anesthesia surgery and entered the PACU for recovery from January 2024 to April 2025 at a medical center were selected and randomly divided into the modified positive pressure extubation group (intervention group) and the traditional extubation group (control group), with 100 cases in each group. Physiological parameters before and after extubation and the incidence of hypoxemia were collected and compared between the two groups. **Results:** The modified positive pressure extubation group showed better fluctuation rates of three physiological parameters—systolic blood pressure, heart rate, and oxygen saturation—after extubation compared to the traditional negative pressure extubation group. The incidence of hypoxemia complications was significantly reduced in the modified positive pressure extubation group. **Discussion:** The modified positive pressure extubation technique buffers the pressure changes at the moment of extubation through positive pressure ventilation, reducing interference with the patient's physiological functions, decreasing stress responses triggered by airway irritation, and maintaining respiratory and circulatory stability in patients. Compared with traditional negative pressure extubation techniques, this technique demonstrates significant advantages in stabilizing physiological

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parameters and reducing complications, especially during the general anesthesia recovery stage in the PACU. Although the current study still has certain limitations, it has a broad application prospect in the future and is expected to provide a safer and more effective option for extubation operations during general anesthesia recovery in the PACU. **Conclusion:** The modified positive pressure extubation technique has significant advantages in general anesthesia recovery in the PACU. It can effectively stabilize physiological parameters after extubation, reduce the incidence of complications, and enhance patient comfort and extubation safety, with high clinical promotion value.

Keywords

Modified Positive Pressure Extubation Technique, PACU (Post-Anesthesia Care Unit), General Anesthesia Recovery, Complications, Physiological Parameters

1. Introduction

Postoperative recovery from general anesthesia is a crucial stage in the surgical process, and tracheal extubation, as an important operation in the recovery process, has a profound impact on the patient's postoperative recovery [1] [2]. In the PACU (Post-Anesthesia Care Unit), ensuring that patients safely and smoothly get through the extubation period is an important guarantee for improving the overall quality of surgery and reducing postoperative complications [3] [4]. Traditional negative pressure extubation techniques, although widely used in clinical practice [5], have many shortcomings. During the extubation process, patients often experience adverse reactions such as blood pressure fluctuations, arrhythmias, and decreased oxygen saturation. These reactions not only increase the patient's pain but can also lead to serious postoperative complications, such as hypertension, tachycardia, and hypoxemia, prolonging the patient's stay in the PACU and affecting the efficient use of medical resources [6] [7]. To overcome the defects of traditional negative pressure extubation techniques, the modified positive pressure extubation technique has emerged. This technique maintains airway patency through positive pressure ventilation, reducing the interference of extubation operations with the patient's physiological state and providing a new solution for PACU general anesthesia recovery. By optimizing extubation techniques, it is expected to improve the quality and safety of PACU general anesthesia recovery, reduce postoperative complications, shorten patient recovery time, and thereby enhance the hospital's medical service efficiency and patient satisfaction, which is of great clinical significance to the development of the anesthesiology discipline.

2. Methods

This study conducted a randomized controlled trial in the PACU of a tertiary hospital in China. The study has been approved by the hospital's ethics committee.

2.1. Study Subjects

A total of 200 patients who underwent general anesthesia surgery and entered the PACU for recovery from January 2024 to April 2025 at a medical center were selected as study subjects. Inclusion criteria: aged 18 - 75 years; ASA grade I - II; patients undergoing general anesthesia surgery planned for extubation in the PACU after surgery. Exclusion criteria: presence of contraindications to extubation, such as severe cardiopulmonary dysfunction, airway abnormalities, or refusal to participate in the study.

2.2. Grouping Method

The 200 patients were randomly divided into the modified positive pressure extubation group (intervention group) and the traditional extubation group (control group), with 100 cases in each group. The randomization process used a computer-generated random number table.

2.3. Extubation Technique Operation Methods

2.3.1. Modified Positive Pressure Extubation Technique (Intervention Group)

After the patient meets the extubation criteria, the ventilator mode is adjusted to spontaneous ventilation mode, and appropriate positive pressure ventilation support is provided, with an inspiratory pressure set at 10 - 15 cmH_2O, positive end-expiratory pressure at 5 cmH_2O, and oxygen concentration at 40% - 60%. During the extubation process, continuous positive pressure ventilation is used to maintain a certain positive pressure in the patient's airway to prevent airway collapse. The specific steps are as follows:

Step 1: Preoxygenation. Administer 100% pure oxygen ventilation via the ventilator for 3 - 5 minutes to ensure adequate oxygen reserve in the patient.

Step 2: Airway clearance. Use a suction device to remove secretions from the trachea and oral cavity to maintain a clean airway.

Step 3: Positive pressure ventilation. Set the anesthetic machine to positive pressure ventilation mode with a pressure of 10 - 15 cmH_2O to maintain alveolar patency.

Step 4: Extubation. Instruct the patient to take a deep breath and hold it for 1 - 3 seconds. At the peak of inspiration, completely deflate the cuff and quickly and gently remove the tracheal tube. Immediately after extubation, instruct the patient to cough spontaneously to clear oral sputum and observe the patient's breathing and oxygen saturation.

2.3.2. Traditional Negative Pressure Extubation Technique (Control Group)

Follow the conventional negative pressure extubation procedure. After the patient meets the extubation criteria, that is, after the patient's spontaneous breathing has recovered and consciousness is clear, the tracheal tube is removed while suctioning, and conventional mask oxygenation is provided after extubation.

2.4. Outcome Measurement

Collect physiological parameters (systolic blood pressure, heart rate, oxygen saturation) before and after extubation and the incidence of hypoxemia for both groups. The specific data collection time points are 5 minutes before extubation, and 5, 10, and 15 minutes after extubation. Hypoxemia is defined as oxygen saturation below 95%, and the incidence of hypoxemia after extubation is recorded.

2.5. Data Analysis

SPSS software was used for data analysis. By comparing the fluctuation rates of systolic blood pressure and heart rate vital signs before and after extubation between the two groups, the impact of the two techniques on the stability of patients' vital signs was determined. By comparing the incidence of hypoxemia after extubation between the two groups, the impact of the two techniques on post-extubation adverse complications was assessed.

3. Results

Table 1 shows the fluctuation rates of systolic blood pressure at different time points after extubation between the intervention and control groups. The p-value was less than 0.001, indicating that the difference between the two groups was statistically significant. The results demonstrate that the intervention significantly reduced the fluctuation rates of systolic blood pressure after extubation. This finding is of great reference value for reducing extubation-related complications and improving patient safety in clinical practice.

Table 1. Comparison of systolic blood pressure between the Intervention Group and the Control Group at 5 minutes before extubation, 5 minutes, 10 minutes, and 15 minutes after extubation.

Group	Systolic Blood Pressure Fluctuation Rate (%) at 5 Minutes After Extubation	Systolic Blood Pressure Fluctuation Rate (%) at 10 Minutes After Extubation	Systolic Blood Pressure Fluctuation Rate (%) at 15 Minutes After Extubation	Sample Size (n)
Control Group	8.69%	13.90%	12.62%	100
Intervention Group	4.34%	4.53%	4.78%	100
		p-value < 0.001		

Table 2 presents the fluctuation rates of heart rate at different time points before and after extubation between the intervention and control groups. The p-value was less than 0.001, indicating that the difference between the two groups was statistically significant. The intervention group had significantly lower heart rate fluctuation rates at all time points after extubation compared to the control group, and the difference became more pronounced as time progressed after

extubation. This suggests that the intervention can effectively reduce the fluctuation of heart rate after extubation, which helps to mitigate the risks associated with abnormal heart rate fluctuations. It is of great clinical significance for improving patient safety after extubation and optimizing extubation management in clinical practice.

Table 2. Comparison of heart rate between the Intervention Group and the Control Group at 5 minutes before extubation, 5 minutes, 10 minutes, and 15 minutes after extubation.

Group	Heart Rate Fluctuation Rate (%) at 5 Minutes After Extubation	Heart Rate Fluctuation Rate (%) at 10 Minutes After Extubation	Heart Rate Fluctuation Rate (%) at 15 Minutes After Extubation	Sample Size (n)
Control Group	23.97%	16.10%	29.94%	100
Intervention Group	10.89%	9.08%	12.94%	100
		p-value < 0.001		

Table 3 shows that the incidence of hypoxemia was 4% in the control group and 9% in the intervention group. The incidence of hypoxemia was significantly higher in the intervention group than in the control group ($p < 0.001$).

Table 3. Comparison of the incidence of hypoxemia after extubation between the Intervention Group and the Control Group.

Group	Incidence Rate (%)	Sample Size (n)
Control Group	9%	100
Intervention Group	4%	100
	p-value < 0.001	

4. Discussion

This study compared the application effects of the modified positive pressure extubation technique and the traditional negative pressure extubation technique in the PACU during the extubation phase after general anesthesia, aiming to provide a better option for clinical extubation operations to improve the quality and safety of postoperative recovery from general anesthesia, reduce postoperative complications, and optimize the utilization efficiency of medical resources.

From the perspective of physiological parameter fluctuations, the modified positive pressure extubation technique showed significant advantages in maintaining the stability of patients' vital signs after extubation. As shown in **Table 1**, the intervention group had significantly lower systolic blood pressure fluctuation rates at all time points after extubation compared to the control group, and the difference was statistically significant ($p < 0.001$). This indicates that the modified positive pressure extubation technique can effectively reduce the interference of extubation

operations with the patient's circulatory system and lower the risk of significant blood pressure fluctuations. After general anesthesia, the patient's physiological functions are in the recovery stage, and the stability of blood pressure is crucial for maintaining the blood perfusion of vital organs. During traditional negative pressure extubation, factors such as negative pressure suction may affect the patient's airway and intrathoracic pressure, thereby causing blood pressure instability [8]. The modified positive pressure extubation technique, through positive pressure ventilation support, provides a relatively stable respiratory environment for patients, which helps to maintain the stability of the circulatory system and reduce blood pressure fluctuations caused by extubation operations. This is of positive significance for preventing postoperative hypertension and other complications and provides strong protection for patients' safe transition in the PACU.

Further analysis of heart rate fluctuations revealed that the modified positive pressure extubation technique is effective in stabilizing patients' heart rates. As shown in **Table 2**, the intervention group had significantly lower heart rate fluctuation rates at all time points after extubation compared to the control group, and the difference became more pronounced as time progressed after extubation ($p < 0.001$). The stability of heart rate is also crucial for postoperative recovery [9] [10], as abnormal heart rate fluctuations can increase the burden on the heart and even lead to serious complications such as arrhythmias. The modified positive pressure extubation technique, by optimizing respiratory management during the extubation process, reduces stimulation to the patient's autonomic nervous system, thereby effectively lowering heart rate fluctuations. In clinical practice, stable heart rate not only helps to reduce the occurrence of cardiac-related complications but also provides a more comfortable postoperative recovery environment for patients, which is beneficial for their psychological recovery [11] [12]. Moreover, stable circulatory system parameters (including blood pressure and heart rate) help the medical team more accurately assess the patient's anesthesia recovery situation, promptly identify and address other potential issues, and improve overall medical quality [13] [14].

In terms of hypoxemia incidence, the modified positive pressure extubation technique also showed positive effects. As shown in **Table 3**, the intervention group had a significantly lower incidence of hypoxemia compared to the control group ($p < 0.001$). This indicates that the modified positive pressure extubation technique can effectively reduce the risk of hypoxemia after extubation. During traditional negative pressure extubation, factors such as negative pressure suction may cause sudden changes in airway pressure, thereby affecting the patient's oxygenation. The modified positive pressure extubation technique, through positive pressure ventilation support, ensures the patency of the airway and the stability of ventilation, reducing oxygenation insufficiency caused by extubation operations. In addition, preoxygenation before extubation and spontaneous coughing after extubation in the modified positive pressure extubation technique also help to clear airway secretions and further improve oxygenation. This result suggests that in

clinical practice, the modified positive pressure extubation technique not only maintains the stability of vital signs but also effectively reduces the risk of hypoxemia, providing safer protection for patients' postoperative recovery [15] [16].

5. Conclusion

The modified positive pressure extubation technique has significant advantages in maintaining the stability of patients' vital signs after extubation, effectively reducing the fluctuations of blood pressure and heart rate, and also shows positive effects in reducing the incidence of hypoxemia. This technique provides safer and more stable protection for the recovery of patients after general anesthesia and has important clinical application value. Although this study has achieved certain results, it also has limitations. First, the sample size is relatively small, and it is a single-center study, which may have selection bias and affect the universality of the results. Second, the study only focused on the short-term physiological parameters and complications after extubation, and the impact of the modified positive pressure extubation technique on patients' long-term prognosis is still unclear. In addition, the specific application parameters and effects of the modified positive pressure extubation technique for different types of surgery and different age groups of patients need further exploration. Future studies should increase the sample size, conduct multicenter clinical trials, further verify the effectiveness and safety of the modified positive pressure extubation technique, strengthen the observation of the long-term effects of this technique, and conduct in-depth research on its application characteristics in different patient groups to provide more sufficient evidence for its clinical promotion.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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