

# Anesthesia Analepsia Management Improves Postoperative Stress Reaction and Oxygenation in Elderly Patients Undergoing Lumbar Spine Surgery

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## Research Article

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# Abstract

**Background:** Developing a scientific and effective anesthesia analgesia management strategy is of great significance to reduce the risk of complications in elderly patients. This study aims to explore the effect of analgesia management on the postoperative stress reaction and oxygenation in elderly patients with lumbar spine surgery.

**Methods:** In this randomized controlled study, 60 elderly patients who underwent lumbar spine surgery with general anesthesia in Traditional Chinese Medicine Hospital of Shapingba District, Chongqing City were included. According to the random number table method, patients were randomly divided into test group (n=30) and control group (n=30). During the analgesia period, patients in the control group received routine management, while the test group received a new analgesia management strategy based on the control group. The analgesia quality, postoperative stress reaction, oxygenation function, and complication rates of the two groups were compared.

**Results:** Compared with the control group, the extubation time, fully awake time, and resuscitation chamber residence time in test group were significantly shortened ( $P<0.05$ ). At different times postoperatively, the test group had significantly lower epinephrine, cortisol, and blood sugar levels than the control group ( $P<0.001$ ), and significantly higher or lower  $\text{PaO}_2$ , oxygenation index (OI), and  $\text{PaCO}_2$  values ( $P<0.01$ ). Compared with the control group, the postoperative visual analogue scale (VAS) score in the test group was lower ( $P=0.05$ ), while the Quality of Recovery-40 (QoR-40) score was higher ( $P=0.05$ ), and the test group had a lower incidence of restlessness, hypothermia and respiratory complications during the analgesia period ( $P<0.05$ ).

**Conclusions:** This study showed that the analgesia management strategy could improve the postoperative stress reaction and oxygenation function of elderly patients with lumbar spine surgery, which could promote the postoperative recovery of patients.

## 1. Background

The lumbar spine is a common site for orthopedic diseases, and the elderly is the largest subset of patients [1]. For most patients, surgery is still the main treatment method [2]. Compared with young patients, the physical and physiological functions of the elderly are significantly reduced, and the elderly often have multiple diseases, which significantly increases the risk of anesthesia [3]. In general anesthesia, the incidence of complications such as postoperative hypothermia, restlessness, hypoxemia, and cognitive dysfunction in the elderly is significantly higher than that in the young [3, 4]. Anesthesia-related complications, especially postoperative cognitive dysfunction, not only prolong the hospital stay and reduce the quality of life but also affect the prognosis of the disease and increase the risk of death [5-7]. Therefore, reducing the risk of anesthesia for elderly patients as much as possible is essential to improve the prognosis of patients.

In the past few decades, clinical anesthesia methods for lumbar spine surgery were extensively and in-depth studied, and many anesthetics and anesthesia programs were developed to further improve the effectiveness and safety of anesthesia<sup>[8, 9]</sup>. However, there is currently no clinical anesthesia method that can completely avoid the risk of complications. It's worth emphasizing that the management during anesthesia is the main component of the patients' surgical process. Few clinical studies focused on further improving the quality of management during anesthesia, especially the anaesthesia period<sup>[10, 11]</sup>. Therefore, developing a scientific and effective anesthesia anaesthesia management strategy is of great significance to reduce the risk of complications in elderly patients. In this study, we tailored an anesthesia anaesthesia management strategy for elderly patients undergoing lumbar spine surgery and focused on observing the effect of the strategy on the postoperative stress reaction and oxygenation function, in order to provide a clinical reference.

## **2. Materials And Methods**

### **2.1 Patients**

The study included 60 elderly patients who underwent lumbar spine surgery at Traditional Chinese Medicine Hospital of Shapingba District, Chongqing City from June 2019 to September 2020. Inclusion criteria: 1) Age  $\geq 60$  years; 2) Classification of American Society of Anesthesiologists (ASA):  $\leq 3$ ; 3) Volunteer to participate in this study and receive elective general anesthesia for lower lumbar spine surgery. Exclusion criteria: 1) Patients previously received lumbar spine surgery; 2) Patients with severe complications such as severe heart, lung, kidney, and liver dysfunction; 3) Patients with severe cognitive dysfunction and other mental illnesses; 4) Patients with diabetes; 5) Patients took the sedatives or antidepressants for a long time before surgery; 6) Patients with severe vision and/or hearing impairment. The patients were randomly divided into the test group (n=30) and the control group (n=30) using the random number table method.

### **2.2 Ethical statement**

This study followed the purpose of the Declaration of Helsinki and was approved by the ethics committee of Traditional Chinese Medicine Hospital of Shapingba District, Chongqing City (No. SPBZYY201901ES). All the patients were informed of the contents of this study and signed an informed consent form.

### **2.3 Anesthesia anaesthesia management**

The patients in the control group were given routine management in the operating room: Preoperative visits were performed on the patients; Baseline information such as the patient's name and age were checked in detail; The precautions during the operation were explained. After the operation, the patients' symptoms and signs were closely monitored. The temperature of the operating room environment was adjusted to be appropriate; The patients' body temperatures are monitored; Liquids such as infusion and irrigation fluids were heated.

Patients in the test group were treated with anesthesia analgesia management strategy on the basis of the control group, including the comprehensive management, which was from preoperative to postoperative extubation process<sup>[12,13]</sup>. The anesthesia analgesia management strategy is shown in Table 1.

## 2.4 Outcome measures

### *Main outcome measures:*

- 1) Analgesia quality: including spontaneous breathing recovery time, extubation time, fully awake time, and resuscitation chamber residence time.
- 2) Stress reaction: When the patient enters the PACU, 3 ml of peripheral venous blood is drawn at 12h and 48h after the operation, epinephrine, cortisol, and the blood glucose, levels of the patient in the fasting state are detected by an automatic biochemical analyzer.
- 3) Oxygenation function: When the patient enters the PACU, at 12h and 24h after the operation, the patient's arterial blood is taken for blood gas analysis, and the arterial partial pressure of oxygen (PaO<sub>2</sub>), the arterial partial pressure of carbon dioxide (PaCO<sub>2</sub>) and oxygenation index (OI).

### *Secondary outcome measures:*

- 1) Postoperative pain and early recovery quality: The pain level of patients at 2h, 4h, 12h, 24h, and 48h after surgery was evaluated by the Visual Analogue Scale (VAS)<sup>[14]</sup>, with a total score of 0-10. The higher the score, the more severe the patient's pain. The quality of early recovery of patients at 12h, 24h, and 48h after surgery was evaluated by the surgical 40-item recovery quality score (QoR-40)<sup>[15]</sup>, and the preoperative 1d was used as a reference. The scale is out of 200 points. The higher the score, the better the patient's recovery quality.
- 2) Complication rates: Record the incidence of restlessness, hypothermia, and respiratory system complications (hypoxemia, glossoptosis, laryngeal edema, etc.) during the analgesia period.

## 2.5 Statistical analysis

SPSS version 23.0 (SPSS, Inc., Chicago, IL, USA) software was applied for statistical analysis of the data. Enumeration data were expressed as the number of cases (percentage) [n (%)], a chi-square test was performed in parallel, and  $\alpha = 0.05$  was selected as test level; measurement data in the study conformed to a normal distribution, expressed as mean  $\pm$  standard deviation ( $\pm s$ ), independent sample t-test was used for comparison, paired t-test was used for comparison before and after the same group, and  $\alpha = 0.05$  was selected as test level;  $P < 0.05$  indicated a statistically significant difference.

## 3. Results

### 3.1 Baseline

There was no significant difference in gender, age, BMI value, type of lumbar spine disease, and ASA classification between the two groups (all  $P>0.05$ ) (Table 2).

### 3.2 Analepsia quality

The two groups of patients had similar spontaneous breathing recovery time (Table 3), and there was no significant difference ( $P>0.05$ ). However, compared with the control group, the extubation time, fully awake time, and resuscitation chamber residence time were significantly shortened in the experimental group (all  $P<0.001$ ) (Table 3).

### 3.3 Postoperative stress reaction

The postoperative epinephrine, cortisol, and blood glucose levels of the patients showed a gradual decrease (Figure 1). There was no significant difference in epinephrine, cortisol and blood glucose levels between the two groups of patients when they entered PACU ( $P>0.05$ ). Compared with the control group, the test group had significantly lower levels of epinephrine (Figure 1A), cortisol (Figure 1B) and blood sugar (Figure 1C) at 12h and 48h after surgery, with significant differences ( $P<0.05$ ).

### 3.4 Postoperative oxygenation function

$\text{PaO}_2$  and  $\text{OI}$  of the two groups of patients decreased firstly and increased after the operation then. In contrast,  $\text{PaCO}_2$  increased firstly and decreased then (Figure 2). There was no significant difference between the two groups of patients in  $\text{PaO}_2$ ,  $\text{PaCO}_2$  and  $\text{OI}$  when they entered PACU ( $P>0.05$ ). Compared with the control group, the test group had significantly higher  $\text{PaO}_2$  and  $\text{OI}$  values at 12h and 24h postoperatively (Figure 2A, 2C), while  $\text{PaCO}_2$  was significantly lower (Figure 2B), and there were significant differences between the groups ( $P<0.01$ ).

### 3.5 Postoperative VAS and QoR-40 score

The VAS scores of the two groups showed a trend of increasing firstly and decreasing then (Figure 3A), while the QoR-40 score decreased firstly and increased then (Figure 3B). There was no significant difference in VAS scores between the two groups at 2h postoperatively ( $P>0.05$ ), while the VAS scores of the experimental group were significantly lower than those of the control group at 4h, 12h, and 24h postoperatively ( $P<0.01$ ) (Figure 3A). There was no significant difference in the VAS score of the two groups at 48 hours postoperatively ( $P>0.05$ ). The preoperative QoR-40 scores of the two groups were not significantly different ( $P>0.05$ ). Compared with the control group, the test group had significantly higher QoR-40 scores at 12h, 24h, and 48h postoperatively ( $P<0.01$ ) (Figure 3B).

### 3.6 Complication rates

Compared with the control group, the incidence of restlessness in the anaesthesia period, hypothermia and respiratory complications in the test group were significantly reduced ( $P<0.05$ ) (Table 4).

## 4. Discussion

Continued advancement of anesthesia technology and the emergence of more effective and safer anesthetics have improved the safety of elderly patients during the perioperative period. However, due to the obvious decline in the functions of the various organs of the elderly and a variety of comorbidities, completely eliminating the risks of anesthesia and surgery is still a huge clinical challenge. In particular, complications during the anaesthesia period, such as delirium, restlessness during recovery, tachycardia, elevated blood pressure, hypoxemia, and varying degrees of consciousness disturbance, have seriously affected the safety of patients during the perioperative period and the prognosis of the operation [3, 4]. In this study, we tailored a systematic anaesthesia management strategy based on the clinical characteristics of elderly patients undergoing lumbar spine surgery, in order to improve the anaesthesia quality and reduce the risk of anesthesia complications. The results of the study showed that the new anaesthesia management strategy effectively improved the anaesthesia quality for elderly patients undergoing lumbar spine surgery, and postoperative stress reaction and oxygenation function got improved as well.

Surgical trauma, anesthesia operations, and emotional changes during the perioperative period all cause a strong stress reaction in patients [16]. In the process of tracheal intubation and tracheal extubation, the strong stimulation of the tracheal tube to the sidewall and glottis of the trachea can reflexly excite the sympathetic nerves, resulting in increased secretion of catecholamines in the body, the blood pressure and heart rate got increased, which seriously affects the patients' health life safety [17, 18]. The stress reaction also promotes the catabolism of sugar, protein and fat, causing continuous increase in blood sugar during and after surgery, leading to difficulty in wound healing and prone to infection [19, 20]. The results of this study showed that the adrenaline, cortisol, and blood sugar levels of the test group at 12h and 48h after surgery were significantly lower than those of the control group, indicating that systematic anaesthesia management strategy can effectively reduce the patients' stress reaction. We analyzed that comprehensive evaluation and active psychological intervention before surgery effectively improved the patients' mental state and reduced the stress reaction caused by mood swings. Previous studies confirmed that interventions in patients with negative emotions could effectively reduce postoperative stress reaction and complication rates [21, 22]. In addition, by screening high-risk patients for special attention, targeted intervention could be carried out during surgery period and the anaesthesia period after surgery, especially the comprehensive management of PACU, which could effectively reduce anesthesia-related complications and thereby reduce the stress reaction.

Many anesthetics can affect the oxygenation function of patients, especially opioids, which can produce obvious respiratory depression [23]. The lung reserve capacity of the elderly is significantly lower than that of the young, and elderly patients are prone to decreased oxygenation in the lungs, impaired lung function, and increased pulmonary complications after general anesthesia. In addition, since the basal

metabolism of the elderly is significantly reduced, residual muscle relaxants are more likely to occur. Studies have confirmed that the residual muscle relaxants significantly increased the respiratory system complications such as airway obstruction, hypoxemia, and respiratory failure<sup>[24]</sup>. In the management of anaesthesia period, we emphasized the monitoring of the oxygenation function of the patient, and the dynamic monitoring of postoperative drug residues, poor breathing, and upper respiratory tract obstruction, so as to effectively prevent complications such as hypoxemia. Study showed that 1/3 of the complications in the recovery period were respiratory and airway complications, and these complications were closely related to tracheal extubation<sup>[25]</sup>. We compared the oxygenation function of the two groups of patients at 12h and 24h after surgery. The results showed that the test group had significantly higher PaO<sub>2</sub>, OI and lower PaCO<sub>2</sub> values than the control group, which suggests that anaesthesia recovery management can effectively improve patients' oxygenation function after the surgical procedures. We analyzed that this may be related to the scientific extubation procedure in the management of anaesthesia period, and we emphasized the appropriate extubation time and extubation method. Extubation in 60° not only reduced the force of extubation, but also reduced the impact on the patients' hemodynamics<sup>[13]</sup>. Keeping a moderate airbag and tracheal pressure during extubation can effectively remove secretions above the airbag, reduce side effects during extubation, and prevent respiratory complications. Continuous and rigorous monitoring after extubation and intervention after anaesthesia further ensured the free of residual muscle relaxants and related complications<sup>[26]</sup>.

The VAS scores of the two groups of patients at different times after surgery showed that the postoperative pain of the test group was significantly reduced, and the VAS scores were lower than the control group at 4h, 12h, and 24h after surgery. The test group had higher QoR-40 scores at 12h, 24h, and 48h after surgery, indicating that the test group had better postoperative recovery quality than the control group. We analyzed that it may be related to the significant reduction of the stress reaction and the lower incidence of complications.

The limitation of this study is that the sample size is small, and the disease type of elderly patients admitted is small. Thus, we need to further increase the sample size and verify the effectiveness of anaesthesia management strategy in elderly patients with other diseases. Besides, we lack a longer follow-up of the elderly patients after surgery, and the effect of anaesthesia recovery management on the long-term outcome of patients is still unclear. We plan to remedy these limitations in future research.

Overall, the results of this study showed that the anaesthesia management strategy could improve the postoperative stress reaction and oxygenation function, reduce the risk of perioperative complications, and promote rapid postoperative recovery of elderly patients undergoing lumbar spine surgery.

## Abbreviations

PaO<sub>2</sub>: Pressure of oxygen; PaCO<sub>2</sub>: Pressure of carbon dioxide; OI: Oxygenation index; QoR-40: the surgical 40-item recovery quality score; PACU: Post Anesthesia Care Unit; BMI: Body Mass Index; ASA: American Society of Anesthesiologists; VAS: Visual Analogue Scale.

# Declarations

## Acknowledgements

Not applicable.

## Authors' contributions

GF, ZC and FR(Tan) participated in project design, clinical data collection, data statistical analysis and collation, and article writing. Q, YZ, and FR(Su) participated in clinical data collection. All authors have read and approved the manuscript.

## Ethics approval and consent to participate

This study followed the purpose of the Declaration of Helsinki and was approved by the ethics committee of Traditional Chinese Medicine Hospital of Shapingba District, Chongqing City (No. SPBZYY201901ES). All the patients were informed of the contents of this study and signed an informed consent form.

## Funding

No funding was received for this study.

## Availability of data and materials

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

## Consent for publication

Not applicable.

## Competing interests

No conflict of interests existed in this study.

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## Tables

Table 1  
The anesthesia anaesthesia management strategy

Items	Specific content
Comprehensive preoperative evaluation	
High-risk population screening	According to the patients' age, weight, medical history, surgery method, anesthesia plan, etc., patients with high risks of restlessness and respiratory complications during the anaesthesia period were screened out, and focused attention, and closely monitored.
Mental State Assessment	Effectively communication with the patients was processed before the operation. The patients' cognitive and psychological status were assessed. According to the patients' education level, occupation, family and other conditions, preventive and targeted management was given.
Preoperative psychological management	The anxiety and tension of the patients were relieved to alleviate the psychological stress. After entering the operating room, we communicated with the patient and diverted their attention.
Intraoperative risk management	
Body temperature management	Warming blankets are used to maintain the patient's normal body temperature. For patients with hypothermia, hang a red low temperature sign on the bedside and cover with a quilt, and pay attention to hyperthermia.
Infusion management	Precisely calculate the input and output volume during the operation, strictly control the input and output liquid volume, and adjust the drip rate.
Respiratory management	Maintain unobstructed breathing and clear respiratory secretions in time.
Analepsia management in the PACU	
Normal management	After entering PACU, check the information carefully and adopt a proper posture. Monitor the patient's blood pressure, heart rate, blood gas and other indicators dynamically to adjust the signs of imbalance. Observe the state of consciousness dynamically and adjust the oxygen flow rate to avoid aspiration.
Body temperature monitoring	Monitor changes in body temperature and control the temperature at 25°C to avoid overheating caused by overheating.
Oxygenation function monitoring	Strengthen arterial blood gas analysis, and dynamically monitor postoperative drug residues, poor breathing, and upper respiratory tract obstruction to prevent hypercapnia and hypoxemia.
Pain intervention	Play soft, soothing, calm music, maintain the volume at 25 dB, and continue to play in a loop until the patient wakes up. According to the patient's postoperative pain, use analgesics as prescribed by the doctor.

PACU: post-anesthesia care unit.

Items	Specific content
Master the timing of extubation	When the patient's breathing rate is < 30 breaths/min, the peak inspiratory pressure is <-20cmH <sub>2</sub> O (1cmH <sub>2</sub> O = 0.098kPa), the vital capacity is > 15ml/kg, the tidal volume is > 6ml/kg, the hemodynamics is stable, no additional support is needed, and the gas exchange is sufficient. (SpO <sub>2</sub> ≥ 93%, measuring arterial blood gas without acidosis when possible) and good recovery of muscle relaxation (head up for more than 5 seconds), extubation may be considered.
Master the extubation technique	Extubation in 60°. Keep moderate airbag and tracheal pressure during extubation.
Intervention after awakening	Prepare first aid supplies. Pay close attention to whether there are residual muscle relaxants. If the patient has abdominal breathing, shortness of breath, weakness, painful expression, etc., report to the doctor in time, open the airway, give oxygen with a mask, and use the antagonist in time. Instruct the patient to relax and breathe evenly.
PACU: post-anesthesia care unit.	

Table 2  
Baseline data

Items	Test group (n = 30)	Control group (n = 30)	t/χ <sup>2</sup>	P
Gender [n(%)]				
Male	12 (40.00)	15 (50.00)	0.606	0.436
Female	18 (60.00)	15 (50.00)		
Age (year)	68.2 ± 5.5	67.8 ± 6.2	0.264	0.793
BMI (kg/m <sup>2</sup> )	23.2 ± 2.5	22.8 ± 2.4	0.632	0.530
Types of lumbar disease [n(%)]				
Spinal stenosis	8 (26.67)	11 (36.67)	0.693	0.405
Lumbar disc herniation	22 (73.33)	19 (63.33)		
ASA classification [n(%)]				
grade I	21 (70.00)	23 (76.67)	0.341	0.559
grade II	9 (32.50)	7 (23.33)		
BMI: Body Mass Index; ASA: American Society of Anesthesiologists.				

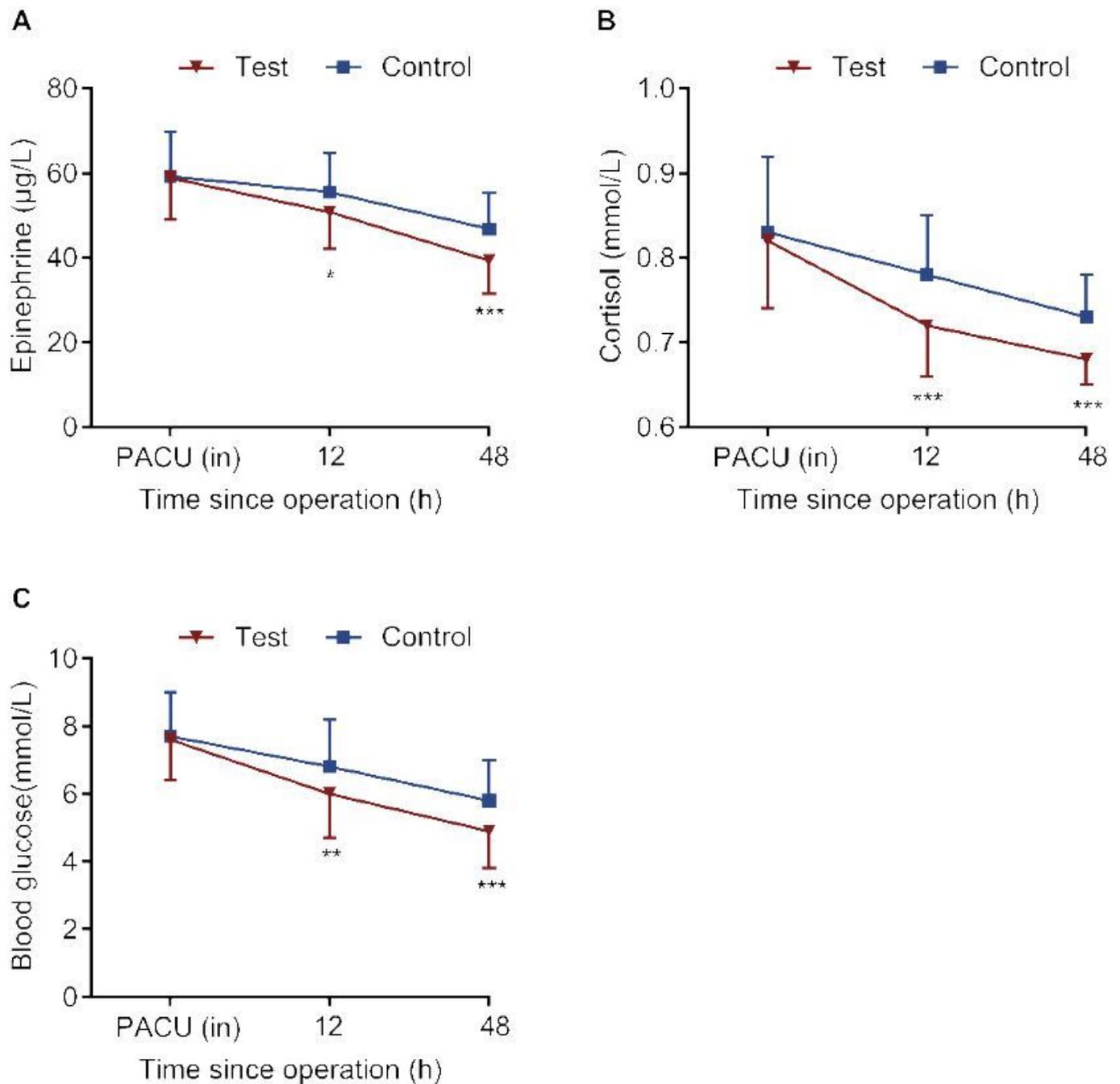
Table 3  
Evaluation of analepsia quality

Items	Test group (n = 30)	Control group (n = 30)	t	P
Spontaneous breathing recovery time (min)	14.9 ± 2.3	14.8 ± 2.5	0.161	0.873
Extubation time (min)	16.2 ± 2.5	19.5 ± 3.2	4.451	< 0.001
Fully awake time (min)	21.8 ± 3.1	29.5 ± 4.5	7.718	< 0.001
Resuscitation chamber residence time (min)	30.3 ± 3.4	45.8 ± 4.2	15.711	< 0.001

Table 4  
Complication rates in the patients.

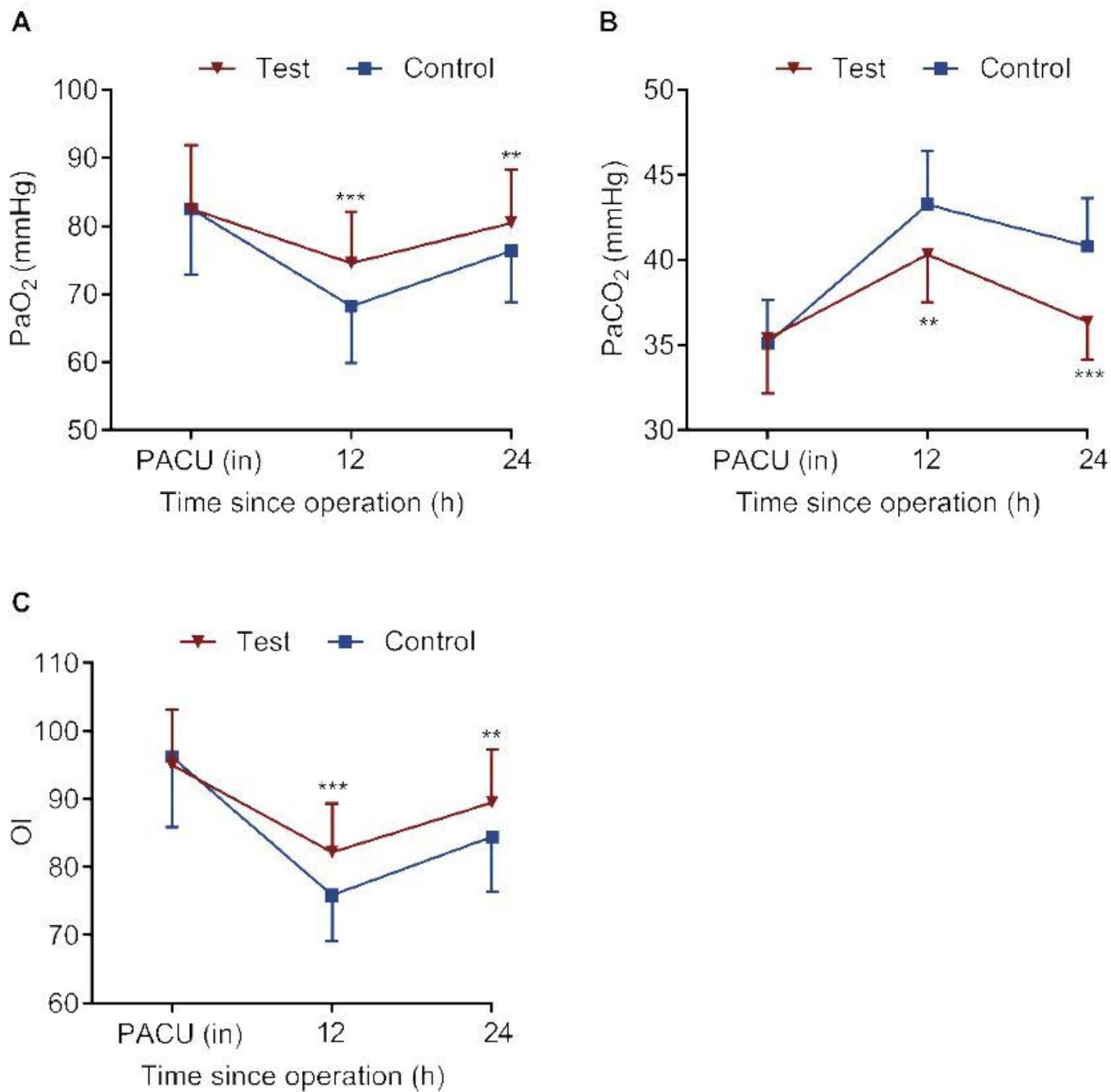
Complications	Test group (n = 30)	Control group (n = 30)	$\chi^2/t$	P
Restlessness in the analepsia period [n(%)]	2 (6.67)	8 (26.67)	4.320	0.038
Hypothermia [n(%)]	1 (3.33)	6 (20.00)	4.043	0.044
Respiratory system complications [n(%)]				
Hypoxemia	1 (3.33)	3 (7.50)		
Glossoptosis	0 (0.00)	3 (10.00)		
Laryngeal edema	0 (0.00)	2 (6.67)		
Total	1 (3.33)	8 (26.67)	6.405	0.011

## Figures



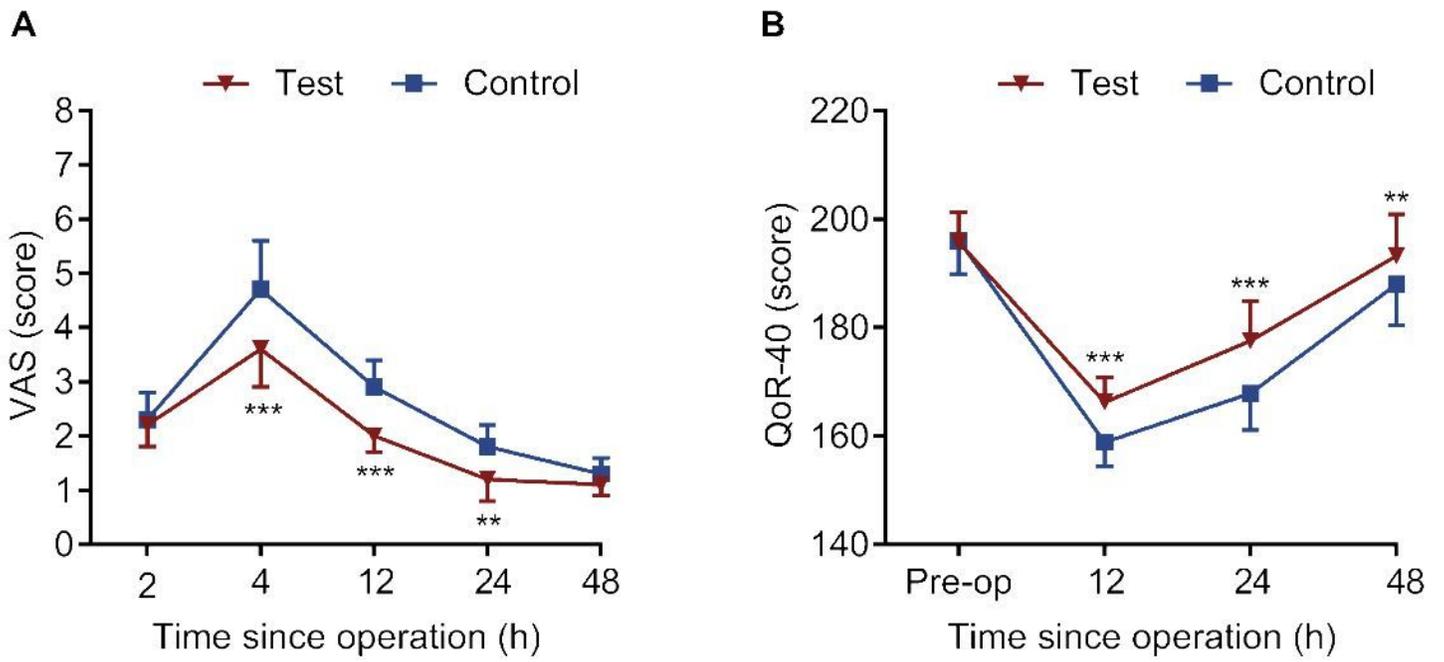
**Figure 1**

Changes in postoperative stress reaction. A. Epinephrine; B. Cortisol; C. Blood glucose. Compared with the control group, \* $P < 0.05$ , \*\* $P < 0.01$ , \*\*\* $P < 0.001$ . PACU means post anesthesia care unit.



**Figure 2**

Changes in postoperative oxygenation function. A. PaO<sub>2</sub>; B. PaCO<sub>2</sub>; C. OI. Compared with the control group, \*\*P<0.01, \*\*\*P<0.001. PaO<sub>2</sub> means arterial partial pressure of oxygen, PaCO<sub>2</sub> means arterial blood partial pressure of carbon dioxide. OI means Oxygenation index. PACU means post anesthesia care unit.



**Figure 3**

Changes in postoperative VAS and QoR-40 Scores. A. VAS score. B. QoR-40 score. VAS means visual analogue scale. QoR-40 means the Quality of Recovery-40 scale.