

# The Influence of Remimazolam General Anesthesia Induction on the Circulatory Stability of Kidney Transplant Patients

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## Abstract

**Objective:** To study the effect of remimazolam general anesthesia induction on the circulatory stability of renal transplant patients. **Methods:** Sixty patients who underwent kidney transplantation in our hospital from December 2023 to April 2025 were selected and randomly divided into the study group and the control group by the random number table method, with 30 cases in each group. In the control group, propofol was used for general anesthesia induction, while in the study group, remimazolam was used for general anesthesia induction. The intraoperative circulatory stability, postoperative anesthesia recovery, and incidence of adverse reactions of the two groups of patients were evaluated and compared. **Results:** At periods such as T1, T2, and T3, the mean arterial pressure and heart rate of patients in the study group were lower than those in the control group, and the difference was statistically significant ( $P < 0.05$ ). The speech response, recovery of spontaneous breathing, recovery of orientation, and postoperative recovery time of the patients in the study group were all shorter than those in the control group, and the difference was statistically significant ( $P < 0.05$ ). The incidence of adverse reactions in the study group was lower than that in the control group, and the difference was statistically significant ( $P < 0.05$ ). **Conclusion:** Remimazolam general anesthesia induction can effectively improve the circulatory stability of kidney transplant patients, promote postoperative anesthesia recovery, and has higher safety at the same time.

## Keywords

Kidney transplantation; Remimazolam; General anesthesia induction; Circulatory stability; Anesthesia recovery period

## 1. Introduction

Kidney transplantation is a commonly used and technologically mature organ transplantation surgery in China at present. It is also an effective treatment method for end-stage renal disease, which is helpful to improve the quality of life of patients and prolong their survival period [1]. General anesthesia is the most commonly used in kidney transplantation surgeries. There are many challenges in intraoperative anesthesia management. Patients who undergo kidney transplantation surgeries are often accompanied by abnormal conditions of the cardiovascular system, respiratory system, etc. to varying degrees [2]. The reserve of cardiopulmonary function will be affected, increasing the difficulty of maintaining circulatory stability during intraoperative anesthesia. During the reperfusion of the donor kidney, patients may experience abnormalities such as blood pressure and heart rate due to the sharp changes in hemodynamics [3], which has a certain negative impact on the surgical and prognostic outcomes. Remimazolam is an anesthetic drug whose application has gradually increased in recent years. As an ultra-short-acting GABAA receptor agonist, it can quickly take effect and enter the anesthetic state after administration [4]. The metabolism of remimazolam does not rely on the liver or kidneys and is metabolized by tissue esterase. Therefore, continuous

infusion will not cause accumulation and can effectively reduce the burden on the liver and kidneys of patients [5]. Meanwhile, studies [6] have found that application of ramazolam during general anesthesia can effectively stabilize the hemodynamic level of patients and ensure the smooth progress of the operation. This study combined the data of some kidney transplant surgery cases admitted to our hospital in recent years to analyze the application value of remimazolam induced by general anesthesia.

## 2. Data and Methods

### 2.1 General Information

Sixty patients who underwent kidney transplantation in our hospital from December 2023 to April 2025 were selected and randomly divided into a study group and a control group by the random number table method, with 30 cases in each group. In the study group, there were 16 males and 14 females, aged 29-68 ( $45.49 \pm 8.23$ ) years. In the control group, there were 17 males and 13 females, aged 30-66 ( $46.12 \pm 8.61$ ) years. There was no statistically significant comparison of data between groups ( $P > 0.05$ ). Inclusion criteria: Those undergoing elective kidney transplantation surgery; It conforms to the indications for the use of anesthetic drugs adopted in this study; Normal cognitive function; The immune system and the coagulation system function normally. Exclusion criteria: Those with functional impairments of other important organs other than the kidneys; People with allergic constitutions; Those with infectious diseases; Those with a history of drug or substance abuse in the past. The research was reviewed and approved by the hospital ethics committee.

### 2.2 Methods

Both groups of patients received elective kidney transplantation surgery. The preoperative routine fasting was 6 hours, and water deprivation was 2 hours. After entering the operating room, assume the supine position for vital sign monitoring and bispectral index (BIS) monitoring of the electroencephalogram, and open the venous access. The specific anesthesia plan is as follows:

#### 2.2.1 Research Group

For anesthesia induction, remimazolam was administered intravenously at a dose of 0.2mg/kg, cisatracurium benzenesulfonate was administered by injection at a dose of 0.2mg/kg, and sufentanil citrate was administered by injection at a dose of 0.3  $\mu\text{g}/\text{kg}$ . Tracheal intubation was performed after the eyelash reflex of the patient disappeared. General anesthesia during the operation was performed by continuous injection of remimazolam at 0.4-1.2mg/(kg·min) and remifentanil at 0.1-0.2mg/(kg·min), stopping the administration 5 minutes after the operation, and adding an appropriate amount of sufentanil.

#### 2.2.2 Control group

Anesthesia induction was performed with propofol administered intravenously at a dose of 2 mg/kg, cisatracurium benzenesulfonate administered by injection at a dose of 0.2 mg/kg, and sufentanil citrate administered by injection at a dose of 0.3  $\mu\text{g}/\text{kg}$ . Tracheal intubation was performed after the eyelash reflex of the patient disappeared. During the operation, general anesthesia was administered with propofol at a dose of 4-10mg/kg and remifentanil at a dose of 0.1-0.2mg/(kg·min), stopping the administration 5 minutes after the operation and adding an appropriate amount of analgesic drugs.

### 2.3 Observation indicators

#### 2.3.1 Intraoperative circulatory stability assessment

The mean arterial pressure, heart rate, etc. of the two groups of patients after entering the room (T0), before intubation (T1), immediately after intubation (T2), and 3 minutes after intubation (T3) were recorded to evaluate the intraoperative circulatory stability.

#### 2.3.2 Evaluation of postoperative anesthesia recovery

Statistical comparisons were made on the speech response, recovery of spontaneous breathing, recovery of orientation, and postoperative recovery time of the two groups of patients during anesthesia recovery.

### 2.3.3 Statistics on adverse reactions

The occurrence of restlessness during the postoperative anesthesia recovery period, choking cough after extubation, chills, etc., in the two groups of patients was statistically analyzed.

## 2.4 Statistical methods

SPSS 26.0 statistical software was used for processing. Measurement data were expressed as ( $\bar{x} \pm s$ ), and the t-test was used for comparison. Count data were expressed as percentages, and  $\chi^2$  test was used for comparison. A P value  $< 0.05$  was considered statistically significant.

## 3. Results

### 3.1 Comparison of intraoperative circulatory stability between the two groups of patients

At periods such as T1, T2, and T3, the mean arterial pressure and heart rate of patients in the study group were lower than those in the control group, and the difference was statistically significant ( $P < 0.05$ ), as shown in Table 1.

**Table 1. Comparison of intraoperative circulatory stability between the two groups of patients ( $\bar{x} \pm s$ )**

Group	MAP ( mmHg )			
	T0	T1	T2	T3
Research group/30	85.69±7.23	99.29±4.31	91.2 ±3.95	98.12±3.13
Control group/30	86.19±7.60	105.69±3.84	94.58±3.12	105.42±4.31
t	0.261	6.073	3.667	7.506
P	0.795	< 0.001	0.001	< 0.001
Group	HR ( Frequency/min )			
	T0	T1	T2	T3
Research group/30	68.49±5.42	75.11±3.94	76.52±3.12	75.62±3.23
Control group/30	67.70±5.81	79.42±2.84	81.21±3.45	80.69±2.93
t	0.545	4.861	5.523	6.368
P	0.588	< 0.001	< 0.001	< 0.001

### 3.2 Comparison of postoperative anesthesia recovery between the two groups of patients

The speech response, recovery of spontaneous breathing, recovery of orientation, and postoperative recovery time of patients in the study group were all shorter than those in the control group, and the differences were statistically significant ( $P < 0.05$ ), as shown in Table 2.

**Table 2. Comparison of postoperative anesthesia recovery between the two groups of patients ( $\bar{x} \pm s$ )**

Group	Speech response time (min)	Recovery time of spontaneous breathing (min)	Orientation recovery time (min)	Postoperative recovery time (min)
Research group/30	6.96±1.29	5.10±1.53	15.49±3.23	5.98±1.30
Control group/30	8.42±2.06	8.20±1.74	19.21±5.41	7.78±1.74
t	3.290	7.328	3.234	4.539
P	0.002	< 0.001	0.002	< 0.001

### 3.3 Comparison of the incidence of adverse reactions between the two groups of patients

The incidence of adverse reactions in the study group was lower than that in the control group, and the difference was statistically significant ( $P < 0.05$ ), as shown in Table 3.

**Table 3. Comparison of the incidence of adverse reactions between the two groups of patients (case%)**

Group	Restlessness during the anesthesia recovery period	Choking when the tube is pulled out	Shivering	Total incidence rate
Research group/30	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)
Control group/30	2 (6.67)	1 (3.33)	1 (3.33)	4 (13.33)
$\chi^2$				4.286
P				0.038

#### 4. Discussion

Kidney transplantation is currently an important means of treating end-stage renal disease. Patients with such conditions are in critical condition and have extremely high requirements for surgical anesthesia. To ensure the smooth progress of the surgery, it is necessary to implement an individual comprehensive assessment before the operation, conducting a comprehensive evaluation of the patients' cardiovascular system, respiratory system, metabolic function [7]. Among them, the assessment of the cardiovascular system is a key component. Patients with end-stage renal disease have a higher risk of cardiovascular system complications, which will increase the risks of anesthesia and surgery. The main purpose of respiratory function assessment is to ensure that patients can maintain effective gas exchange during the operation. In kidney transplantation surgery, circulatory management is the core content of surgical anesthesia, especially the hemodynamic fluctuations during the reperfusion period of the donor kidney. During the reperfusion of the donor kidney, a large amount of fluid and metabolites enter the circulatory system, which will directly affect the circulatory stability of the patient. Maintaining a stable circulation is conducive to ensuring the perfusion of the donor kidney and the function of the recipient's organs. Patients with end-stage renal disease have varying degrees of electrolyte and acid-base balance disorders. Operations such as surgery and anesthesia can aggravate this disorder and affect the respiratory and circulatory functions of the patients.

This study analyzed the effect of remimazolam general anesthesia induction on the circulatory stability of kidney transplant patients. It showed that at time periods such as T1, T2, and T3, the mean arterial pressure and heart rate of patients in the study group were lower than those in the control group, and the intraoperative circulatory stability of patients in the study group was significantly better than that in the control group. Remimazolam can rapidly act on GABA receptors after administration, degrade to form zolampropionic acid, promote the flow of chloride ions into neuronal cells, and exert a good analgesic effect. At the same time, this drug does not need to be metabolized by the liver, and thus does not cause accumulation [8]. Study [9] found that remimazolam, after administration, enhances the inhibitory effect of GABA by selectively acting on GABA-A receptors in the central nervous system, exerting better sedative and hypnotic effects. Compared with commonly used anesthetic drugs, remimazolam has a smaller inhibitory effect on the sympathetic nerve of the body and can reduce the impact on the cardiovascular system. During the induction process of general anesthesia, excessive inhibition of the sympathetic nerve is prone to cause a decrease in blood pressure and a decrease in heart rate. However, remimazolam can effectively avoid excessive inhibition and stabilize the hemodynamic level of patients by selectively activating GABA-A receptors.

The speech response, recovery of spontaneous breathing, recovery of orientation, and postoperative recovery time of the patients in the study group were all shorter than those in the control group. Meanwhile, the incidence of adverse reactions in the study group was lower than that in the control group, indicating that remimazolam can effectively promote postoperative recovery and has high safety. Remimazolam is mainly metabolized by tissue esterase. Patients undergoing kidney transplantation often have varying degrees of impairment in liver and kidney functions. Traditional anesthetic drugs may accumulate in the body due to the decline in liver and kidney metabolic functions, increasing the risk of adverse reactions [10]. The metabolism of remimazolam is not affected by liver or kidney diseases and can be rapidly metabolized in the body, reducing the possibility of drug accumulation. This feature enables more precise control of the depth of anesthesia during the operation, adjustment of the drug dosage based on the individual condition of the patient, ensures the safety of medication use, and promotes early postoperative recovery. Relevant studies [11] have found that remimazolam has a relatively mild respiratory inhibitory effect and can better maintain the respiratory function of patients during anesthesia induction and maintenance.

In conclusion, the application of remimazolam general anesthesia induction in kidney transplant patients can ensure the stability of intraoperative circulation, promote early postoperative anesthesia recovery, and enhance the safety of anesthesia. It has a relatively high application value.

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