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Original Research Article

Anesthetic effect of sufentanil in patients undergoing cardiovascular surgery

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Abstract

Purpose: *To investigate the effect of sufentanil on anesthesia in patients undergoing cardiovascular surgery.*
Methods: *The subjects comprised a total of 100 patients who were scheduled to undergo cardiovascular surgery in Taikang Tongji (Wuhan) Hospital from January 2021 to December 2021 and met the inclusion criteria. The eligible patients were assigned in a ratio of 1:1 to receive either remifentanil (control group) or sufentanil (study group) during cardiovascular surgery, with 50 patients in each group. The anesthetic effect of remifentanil and sufentanil was compared.*
Results: *Patients treated with sufentanil experienced a faster onset of anesthesia and a shorter time-lapse before extubation, postoperative spontaneous breathing recovery, and postoperative anesthesia recovery when compared with those administered with remifentanil ($p < 0.05$). Sufentanil provided more potent pain mitigation for patients undergoing cardiovascular surgery than remifentanil, as shown by the lower visual analogue scale (VAS) scores of patients in the study group ($p < 0.05$). Patients administered with sufentanil showed better levels of mean arterial pressure (MAP) and oxygen saturation (SpO_2) than remifentanil, suggesting better hemodynamic benefits provided by sufentanil ($p < 0.01$). During cardiovascular surgery performed in this study, sufentanil resulted in a higher safety profile by reducing significantly the incidence of adverse reactions (6 %) than remifentanil (30 %) ($p < 0.01$).*
Conclusions: *Sufentanil exhibits a better anesthetic effect in patients undergoing cardiovascular surgery than remifentanil. It provides potent pain mitigation, effectively ameliorates patients' hemodynamic status, and reduces the risk of adverse reactions. Future studies with larger sample sizes are required to validate these findings.*

Keywords: *Sufentanil, Cardiovascular surgery, Anesthesia, Effect analysis*

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INTRODUCTION

Cardiovascular diseases comprise ischemic or hemorrhagic diseases caused by hyperlipidemia, arteriosclerosis, blood viscosity, and hypertension [1,2]. These diseases feature high morbidity and mortality, especially among middle-aged and elderly people [3,4]. Cardiovascular diseases are mostly managed by medication or surgery. Sternotomy is a common

procedure for the care of cardiovascular surgery. However, it causes large surgical trauma and consequently intense postoperative pain.

The use of appropriate anesthetic drugs is of great significance to mitigate postoperative pain, improve hemodynamic status, and prognosis of patients [5,6]. Sufentanil and remifentanil are novel opioid receptor agonists, which are commonly used in clinical operations [7-9].

Thus, in this study, patients undergoing elective cardiovascular surgery were anesthetized with either sufentanil or remifentanil, in order to evaluate and compare the anesthetic effect of the two drugs.

METHODS

Subjects

The subjects comprised a total of 100 patients scheduled to undergo cardiovascular surgery in Taikang Tongji (Wuhan) Hospital from January 2021 to December 2021 and met the inclusion criteria. The eligible patients were assigned in a ratio of 1:1 to receive either remifentanil (control group) or sufentanil (study group) during cardiovascular surgery, with 50 patients in each group. All the included patients had normal immune function.

Ethics approval and consent to participate

This clinical study protocol was approved by the Ethics Committee of Taikang Tongji (Wuhan) Hospital (approval no. 20220715). All subjects enrolled in the study signed an informed consent form and were informed of the purpose, content, and use of the study. All the methods were carried out in accordance with the Declaration of Helsinki [10].

Inclusion and exclusion criteria

Inclusion criteria

Patients who met the cardiovascular diagnostic criteria, without medication related to the study within one month, with good treatment compliance, met the ASA classification grade I - III, and who agreed to participate in the study and signed informed consent were included.

Exclusion criteria

Patients with surgical contraindications, allergic history of narcotic drugs, renal dysfunction, congenital diseases, or malignant tumors, or who rescinded their consent were excluded.

Procedures and treatments

The routine preoperative examination was carried out in both groups after admission. Patients were nil by mouth for 24 h before surgery, and relevant preoperative preparation was completed. Intraoperatively, changes in the physical indicators of patients were monitored using a multifunctional monitor and recorded. Anesthesia induction was performed using fentanyl (4.0 μg/kg), propofol (1.5 mg/kg), and atracurium (0.15 mg/kg) for patients in both groups. The state of consciousness and respiration of patients in both groups were closely monitored after surgery. The tracheal catheter was removed after the patient regained consciousness and breathing. Patients in the control group were administered remifentanil at 0.5 g/kg/min for anesthesia, while those in the study group were anesthetized with sufentanil at a maximum dose of 1.0 g/kg. The timing of the peak blood concentration of the drug was controlled at 25 min.

Evaluation of parameters/indices

Anesthetic effect and Visual analogue scale (VAS) score

The anesthetic effects in the two groups were evaluated by comparing the onset of anesthetic effect and time-lapse before extubation, postoperative spontaneous breathing recovery, and postoperative anesthesia recovery. A visual analogue scale (VAS) was used to evaluate the analgesic effect on patients. The higher the score, the more severe the pain.

Hemodynamic status

The mean arterial pressure (MAP) and oxygen saturation (SpO_2) of the two groups were compared and monitored before surgery (T), during surgery (T1), and 30 minutes after surgery (T2).

Incidence of adverse reactions

The adverse reactions (A) of the two groups were compared, including arrhythmia, nausea and vomiting, chills, and dizziness. The incidence of adverse reactions (I) was calculated using Eq 1.

$$I = (A/T)100 \quad \text{..... (1)}$$

where A = number of cases with adverse events, and T = total number of cases

Statistical analysis

Statistical analysis was performed using Statistical Package for the Social Sciences (SPSS) ver. 22.0 (IBM, Armonk, NY, USA). Descriptive statistics were performed for quantitative data and results are expressed as mean ± standard deviation (SD) while qualitative data were compared by chi-square, and the results are presented as χ^2. $P < 0.05$ was reported as statistically significant.

RESULTS

Baseline patient data

There were 31 males and 19 females in the control group, aged 45.68 ± 3.19 years, with a mean BMI of 21 – 31 (24.89 ± 2.14) kg/m^2. There were 21 cases with a junior college degree or below and 29 cases with an undergraduate or above in terms of education level; 33 cases were classified as ASA grade I and 17 cases were ASA grade II. There were 18 cases of congenital cardiovascular diseases and 32 cases of acquired cardiovascular diseases. In the study group, there were 28 males and 22 females aged 46.27 ± 3.37 years, with a mean BMI of 20 – 30 (24.96 ± 2.77) kg/m^2. There were 19 cases with a junior college degree or below and 31 cases with an undergraduate or above in terms of education level; 27 cases were classified as ASA grade I and 23 cases were ASA grade II. There were 19 cases of congenital cardiovascular diseases and 31 cases of acquired cardiovascular diseases. The two groups were well-balanced in terms of baseline patient profiles ($p > 0.05$) (Table 1).

Anesthetic effect and postoperative pain

Patients treated with sufentanil experienced a faster onset of anesthetic effect and a shorter time-lapse before extubation, postoperative spontaneous breathing recovery, and postoperative anesthesia recovery when compared with those administered with remifentanil ($p < 0.05$). Sufentanil provided more potent pain mitigation for patients undergoing cardiovascular surgery than remifentanil, as shown by the lower VAS scores of patients from the study group ($p < 0.05$). (Table 2)

Hemodynamics

Patients administered with sufentanil showed better levels of MAP and SpO_2 than remifentanil, suggesting better hemodynamic benefits provided by sufentanil ($p < 0.01$, Table 3).

Table 1: General data of patients in the two groups (n = 50)

Parameter	Item	Control group	Study group	*t/x²*	*P*-value
Gender	Male	31	28	0.372	1.846
	Female	19	22		
Age (year)	Mean	45.68±3.19	46.27±3.37	0.899	1.361
BMI (kg/m^2)	Mean	24.89±2.14	24.96±2.77	0.141	1.172
Education level	Undergraduate and above	29	31	0.166	2.167
	Junior college and below	21	19		
ASA classification	Grade I	33	27	1.501	1.692
	Grade II	17	23		
Etiology	Congenital cardiovascular disease	18	19	0.042	1.361
	Acquired cardiovascular disease	32	31		

Note: t represents the statistic results of quantitative data, while x² represents the statistic results of qualitative data

Table 2: Comparison of anesthetic effect and VAS score between the two groups (mean ± SD, n = 50)

Group	Onset of anesthetic effect (min)	Time-lapse before postoperative anesthesia recovery (min)	Time-lapse before postoperative spontaneous breathing recovery (min)	Time-lapse before extubation (min)	VAS score
Control group	6.32±1.28	7.49±1.14	15.24±3.51	23.67±4.77	4.86±2.14
Study group	3.19±0.47	4.08±0.33	12.19±1.13	15.42±3.66	2.25±1.14
x²	16.231	20.317	5.548	9.702	7.611
P-value	<0.01	<0.01	<0.01	<0.01	<0.01

Table 3: Comparison of hemodynamics parameters between the two groups (mean ± SD, n = 35)

Parameter	Time component	Control group	Study group	*t*	*P*-value
MAP (Kpa)	T	15.27±1.44	15.19±1.35	0.286	1.351
	T1	13.41±1.25	12.22±1.11	5.033	<0.01
	T2	11.93±1.07	10.48±1.01	6.968	<0.01
SpO_2 (%)	T	99.48± .35	99.45±0.38	0.416	1.715
	T1	98.27±0.29	96.16±0.21	4.167	<0.01
	T2	97.24 ± 0.24	95.09 ± 0.13	5.569	p<0.01

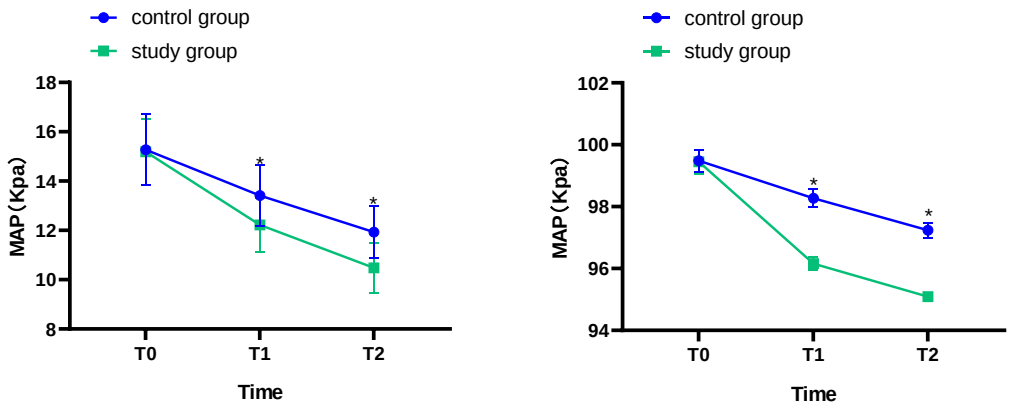

Figure 1: Comparison of hemodynamic parameters between the two groups. *Statistical difference between the two groups

Table 4: Comparison of incidence of adverse reactions between the two groups (n = 50)

Group	Nausea and vomiting	chills	dizzy	Abnormal heart rate	Total incidence (%)
Control	7	3	3	2	11 (30.00)
Study	1	0	1	1	3 (6.00)
x^2					19.512
P-value					<0.01

Incidence of adverse reactions

During cardiovascular surgery performed in this study, sufentanil resulted in a higher safety profile by reducing significantly the incidence of adverse reactions (6 %) than remifentanil (30 %) ($p < 0.01$) (Table 4).

DISCUSSION

Cardiovascular diseases are a global public health concern due to the high mortality and morbidity [10]. According to the China Cardiovascular Health and Disease Report in 2021, China still tops the list of morbidity and mortality due to cardiovascular diseases, accounting for two out of every five deaths [11]. Surgery is effective for the management of cardiovascular diseases. However, patients undergoing cardiovascular surgery usually experience negative emotions and severe postoperative pain, which results in a poor prognosis [12]. Thus, the use of anesthetic drugs in cardiovascular surgery is of great significance [13]. Remifentanil and sufentanil are common analgesic and narcotic drugs in clinical practice [14]. However, recent studies have reported several adverse events associated with remifentanil, which may cause hypotension, nausea, vomiting, or bradycardia. Sufentanil is a benzidine derivative that binds to and activates the mu-opioid receptor, thereby producing analgesia [15]. It has been shown that sufentanil is approximately 5 to 10 times as potent as its parent drug, fentanyl. Sufentanil is also the anesthetic drug with the longest duration of anesthesia and the best analgesic effect among fentanyl drugs [16]. Sridharan *et al* [17] also revealed that sufentanil produced better anesthetic and analgesic effects than remifentanil.

In the present study, patients treated with sufentanil experienced a faster onset of anesthetic effect and a shorter time-lapse before extubation, postoperative spontaneous breathing recovery, and postoperative anesthesia recovery when compared with those administered with

remifentanil, and sufentanil provided more potent pain mitigation for patients undergoing cardiovascular surgery than remifentanil. Relevant studies have shown that sufentanil effectively blocks the transmission of pain signals to the central nervous system during uterine surgery and features rapid action as well as metabolism. Previous studies have shown that sufentanil exerts its medicinal properties to the fullest in a relatively short period of time and provides better oxygen supply to the myocardial muscle of patients during surgery, thereby avoiding the occurrence of immunosuppressive force and hemolytic reaction. Wu *et al* [18] suggested that sufentanil effectively maintains hemodynamic stability and reduces complications. In the present study, patients administered with sufentanil showed better levels of MAP and SpO_2 than remifentanil, suggesting better hemodynamic benefits provided by sufentanil, and during cardiovascular surgery performed in this study, sufentanil resulted in a higher safety profile by reducing significantly the incidence of adverse reactions (6 %) than remifentanil (30 %).

Limitations of this study

There are still some limitations in this study. For example, the small sample size has the risk of bias. The postoperative follow-up time is short, and the post-discharge compliance and other factors were not discussed.

CONCLUSION

Both remifentanil and sufentanil have good anesthetic effects in surgical anesthesia for the treatment of cardiovascular diseases. Sufentanil has more significant anesthetic effect in cardiovascular surgery, as it offers a faster onset of anesthetic effect and a shorter time-lapse before extubation, postoperative spontaneous breathing recovery, and postoperative anesthesia recovery, reduces postoperative pain, and stabilizes the hemodynamic status of the patients. Future studies with larger sample sizes are required to validate these findings.

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.

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