

# Effects of Dexmedetomidine or Propofol on Postoperative Oxygenation Index During Invasive Ventilation in Patients After off-Pump Coronary Artery Bypass Grafting: a Single-Center Retrospective Study

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**Purpose:** This study aimed to compare the effects of dexmedetomidine (DEX) and propofol on patients undergoing invasive ventilation after off-pump coronary artery bypass grafting (OPCABG) with regard to oxygenation index (OI) (PaO<sub>2</sub>/FiO<sub>2</sub>), hemodynamic changes, extubation time, and adverse reactions.

**Patients and Methods:** This single-center retrospective study included 195 patients admitted to the cardiovascular surgery intensive care unit (CVICU) after OPCABG between January 2022 and June 2024. According to the postoperative invasive mechanical ventilation for sedation with only DEX or propofol, the patients were classified into groups D and P. The primary outcome was oxygenation index (OI) before and after extubation. The secondary outcomes included mean arterial pressure (MAP) and heart rate (HR) before and after extubation, extubation time, and adverse reactions after surgery.

**Results:** DEX was significantly associated with an increased likelihood of OI before and after extubation compared to propofol ( $P < 0.05$ ). MAP and HR after extubation were significantly higher than before extubation in Group P ( $P < 0.05$ ). However, there were no significant differences between before and after extubation in Group D ( $P < 0.05$ ). Furthermore, MAP and HR were significantly lower in Group D than in Group P before and after extubation ( $P < 0.05$ ). In addition, the extubation time was significantly shorter in Group D in comparison of propofol ( $P < 0.05$ ). Additionally, the incidence of delirium and severe cough at extubation after surgery was significantly lower in Group D than in Group P ( $P < 0.05$ ).

**Conclusion:** DEX may support satisfactory OI, good hemodynamic stability, rapid extubation time, and a lower incidence of adverse reactions for sedation of mechanically ventilated patients following OPCABG surgery compared to propofol, although the difference with OI did not reach the MCID.

**Keywords:** dexmedetomidine, propofol, oxygenation index, invasive ventilation, off-pump coronary artery bypass grafting

## Introduction

Coronary heart disease (CHD) is a common clinical cardiovascular disease, and surgical coronary artery bypass grafting (CABG) is the standard of care for revascularization of left main or three-vessel coronary artery disease.<sup>1,2</sup> Mechanical ventilation is one of the most critical steps in the postoperative period of CABG because of the high-dose opioid-based anesthesia and the initial vulnerable hemodynamic state.<sup>3</sup> However, prolonged mechanical ventilation is associated with deleterious effects, including increased infectious complications, mortality, intensive care unit (ICU) and length of hospital stay (LOS). Recovery of respiratory function, successful weaning, and extubation after cardiac surgery are important steps in the postoperative recovery.<sup>4</sup>



The oxygenation index (OI) (PaO<sub>2</sub>/FiO<sub>2</sub>) is an important indicator for predicting lung function and successful removal of patients from invasive mechanical ventilation support.<sup>5</sup> Sedation is prescribed to patients admitted to the ICU after surgery to reduce patient discomfort, ventilator asynchrony, tolerable mechanical ventilation, prevent accidental device removal, and reduce metabolic demands during respiratory and hemodynamic instability.<sup>6,7</sup>

Currently, newer drugs available for sedation may play an important role in decreasing postoperative pulmonary complications (eg, postoperative atelectasis and hypoxemia), duration of mechanical ventilation, length of ICU stay, and may have a certain protective effect on lung function.<sup>6</sup> Currently, propofol and dexmedetomidine (DEX) have very different mechanisms of action and pharmacokinetic profiles, making them attractive sedative agents for cardiovascular surgeries following postoperative mechanical ventilation.<sup>8</sup>

Propofol is a classic sedative used in the ICU after cardiovascular surgery and has advantages in terms of quick onset, easy adjustment, and fast recovery after discontinuation. In addition, recent reports also showed that it could reduce inflammation, reduce oxidative stress, inhibit lung tissue apoptosis, protect against lung ischemia/reperfusion (I/R) injury and improve lung function.<sup>9,10</sup> DEX is a novel, highly selective  $\alpha_2$  adrenergic receptor ( $\alpha_2$ AR) with sedative, analgesic sparing, anxiolytic, and sympatholytic properties, more hemodynamic stability, and without causing respiratory depression. It is also used for sedation of ICU patients after cardiac surgery during mechanical ventilation and offers more advantages with regard to reducing the duration of mechanical ventilation, decreasing the incidence of postoperative pulmonary complications, and having a protective effect on pulmonary function, which may be related to the regulation of oxidative stress reactions and a reduction in the concentration of inflammatory cytokines.<sup>11–13</sup> Previous clinical studies have shown that DEX can improve OI in patients during mechanical ventilation.<sup>14,15</sup> Propofol was also reported by Abe et al<sup>16</sup> that oxygenation and shunt fraction were improved during one-lung ventilation compared with isoflurane and sevoflurane. In addition, Ruan et al<sup>9</sup> revealed that propofol exerted its protective function against ventilator-induced lung injury and the subsequent inflammatory responses through activating Nrf2 and inhibiting NLRP3 expression in mouse models.

Nevertheless, research on the impact of DEX and propofol on postoperative OI in patients after cardiac surgery is still lacking. Hence, we sought to compare postoperative sedation techniques with DEX versus propofol infusions on the postoperative OI of patients following off-pump coronary artery bypass grafting (OPCABG) in the cardiovascular surgery intensive care unit (CVICU). We also aimed to investigate the hemodynamic changes, extubation times, and adverse reactions.

## Materials and Methods

### Ethical Statement for Collecting Clinical Information

This study was a single-center retrospective observational trial approved by the Research Ethics Committee of the Provincial Hospital Affiliated to Shandong First Medical University (SWYX: NO.2024–306) and adhered to the Declaration of Helsinki and the STROBE guidelines before trial registration with the number ChiCTR2400087672 (<http://www.chictr.org.cn/>). The need for informed consent was waived because of the retrospective nature of the study. The research ethics committee waived the need for written informed consent based on the minimal risk to patients.

### Study Design and Patients Selection

This study included 195 patients admitted to the CVICU after OPCABG in the hospital between January 2022 and June 2024. Data were collected from patients' electronic medical records.

To minimize selection bias, data collection was performed by an independent nurse who was blinded to the research objective and statistical analysis was performed by an independent physician. According to postoperative mechanical ventilation using only propofol or DEX for sedation, all participants were divided into two groups: Group P and Group D.

### Inclusion Criteria and Exclusion Criteria

The inclusion Criteria were as follows: (1) patients who required mechanical ventilation upon arrival to the CVICU after OPCABG and received only DEX or propofol as the initial choice of sedative agent, (2) aged 60–75 years, and (3) American Society of Anesthesiologists (ASA) grade III–IV. Exclusion Criteria: (1) Perioperative cognitive impairment;

(2) Preoperative heart failure; (3) Severe respiratory system disease; (4) Auto-immune diseases; (5) Malignant tumour history; (6) Perioperative severe liver and kidney dysfunction; (7) a prior solid organ transplant; (8) Recent use of antidepressants, sedatives, analgesics, or hormonal drugs; (9) History of drug allergy in research; (10) Patients received DEX during surgery, or both DEX and propofol concurrently for sedative during invasive ventilation periods; (11) Patients received other sedatives concurrently intraoperatively or postoperatively, with the exception of an induction dose of etomidate at the start of the case and midazolam; (12) History of previous chest surgery (e.g., percutaneous coronary intervention, respiratory surgery); (13) Redo CABG; (14) Underwent tracheotomy after surgery; (15) Incomplete perioperative data; (16) Other factors considered to have an impact on the results of this study (e.g., peripheral oxygen saturation <94% breathing room air/active smoking, atrioventricular-conduction block Grade II or III without pacemaker installed, low cardiac output syndrome, the adjunctive therapy of intra-aortic balloon pump, a heart beating on-pump surgery was performed using partial assistance from the cardiopulmonary bypass).

## Anesthesia and Operative Technique

All patients underwent routine monitoring, intravenous inhalation combined anesthesia, and volume-controlled mechanical ventilation with a lung-protective ventilation approach during anesthesia to meet surgical requirements. Anesthesia was induced with etomidate, sufentanil, and cisatracurium. Anesthesia was maintained with infusion of midazolam, propofol, sevoflurane, sufentanil, and cisatracurium when required during surgery.

The participants underwent an OPCABG procedure with a normal heartbeat and standard median sternotomy. Active cardiovascular medications were administered according to the patient's condition.

## CVICU Management

All the patients were admitted directly to the CVICU after surgery and continued to receive respiratory and circulatory support. The mechanical ventilation mode was volume-controlled ventilation (8 mL/kg), with a fraction of inspired oxygen (FiO<sub>2</sub>) (40–80) and respiratory rate (RR) adjustments based on routine blood gas analyses to maintain the partial pressure of arterial oxygen (PaO<sub>2</sub>) (80–100 mm Hg) and partial pressure of arterial dioxide (PaCO<sub>2</sub>) (35–45 mm Hg).

The participants only received DEX (0.2 to 1.5 µg/kg/h) or propofol (5 to 50 µg/kg/min) for sedation, and fentanyl (0.5 to 1 µg/kg/h) for analgesia, with doses adjusted to achieve target sedation goals set by clinicians according to the patient's haemodynamic responses and the Richmond Agitation-Sedation Scale (RASS). The selection of sedative agents is determined through a multidisciplinary decision-making process involving CVICU physicians and cardiac surgeons. This clinical decision is systematically guided by comprehensive evaluation of the patient's physiological status, pharmacological profiles of therapeutic agents, and real-time hemodynamic monitoring data, with the ultimate objective of optimizing therapeutic efficacy while mitigating adverse pharmacological interactions. Such an evidence-based approach ensures precise pharmacotherapeutic management tailored to individual patient characteristics and dynamic clinical requirements.

The weaning criteria included hemodynamic stability with minimal vasopressor or inotropic support, mediastinal bleeding <100 mL within the first hour or <500 mL within 4 hours, OI ≥200 with PEEP <5 cmH<sub>2</sub>O, and FiO<sub>2</sub> ≤50%. Once the weaning standard was met, the sedative drug infusion was stopped. The formal assessment for mechanical ventilation discontinuation was performed by a spontaneous breathing test (SBT) using a T-piece with supplemental oxygen supply to ensure SpO<sub>2</sub> ≥95%. The endotracheal tube was removed if the patient had a satisfactory assessment and clear consciousness. The extubated patients received oxygen via nasal prongs or face masks and were closely monitored for SpO<sub>2</sub>. Furthermore, noninvasive or invasive mechanical ventilation was initiated if necessary.

## Outcomes

The primary outcome was the OI before and after extubation. The secondary outcomes included mean arterial pressure (MAP) and heart rate (HR) before and after extubation, extubation time (number of minutes from the end of surgery to the initial extubation after arrival at the CVICU), and adverse reactions after surgery.

## Data Collection

Demographic data such as age, sex, body mass index (BMI), NYHA classification, ASA classification, MAP, HR, hypertension, left ventricular ejection fraction (LVEF), valvular disease, atrial fibrillation, coronary artery disease (CAD) classification, obstructive sleep apnea (COPD), asthma, obstructive sleep apnea (OSA), PO<sub>2</sub>, OI, smoking history, cerebrovascular disease, diabetes, creatinine (Cr), and preoperative hemoglobin levels were collected. Intraoperative data included the number of diseased vessels, duration of anesthesia, and duration of surgery. Postoperative data included postoperative hemoglobin, OI before and after endotracheal tube extubation, MAP and HR before and after extubation, and extubation time. Postoperative adverse reactions were defined as delirium, stroke, and severe cough during extubation (and cough grade was assessed using a 4-point scale: 0 = no cough; 1 = mild, single cough; 2 = moderate, more than one non-sustained cough episode (lasting for < 5 seconds); and 3 = severe, sustained, and repetitive cough with head lift (lasting for > 5 seconds)),<sup>17</sup> extubation failure (OI ≤ 200 mmHg and required mechanical ventilation for more than 48h), new-onset arrhythmia, hypotension, bradycardia, acute kidney injury, and pneumonia.

## Statistical Analyses

Continuous variables are described as mean (standard deviation) or median (interquartile range), as appropriate, and categorical variables as frequencies and percentages.  $\chi^2$  or Fisher's exact test was used to evaluate the significance of the differences in categorical variables between the two groups. For continuous variables, after the normality test, we used the *t*-test for normally distributed data and Mann-Whitney *U*-test for non-normally distributed data. All tests were 2-sided, at *P*-value < 0.05 was considered statistically significant. All statistical analyses were performed using SPSS software (version 23.0; IBM Corp, Armonk, NY, USA).

Minimal clinically important difference (MCID) determination: Retrieve the current database and clinical guidelines, the MCID value closely related to this study has not been reported. Therefore, we adopt the classic anchor-based method, and define the threshold based on the association between OI changes (after extubation) and patient's core indicators closely related to disease progression (the need for non-invasive mechanical ventilation after extubation) through receiver operating characteristic curve (ROC) curve analysis.<sup>18–20</sup> Furthermore, three experts in the field discuss the results and ultimately decided on MCID.<sup>21</sup> In addition, we further compare the difference in mean change with the MCID. The difference in mean change exceeding the MCID would substantiate clinical relevance.

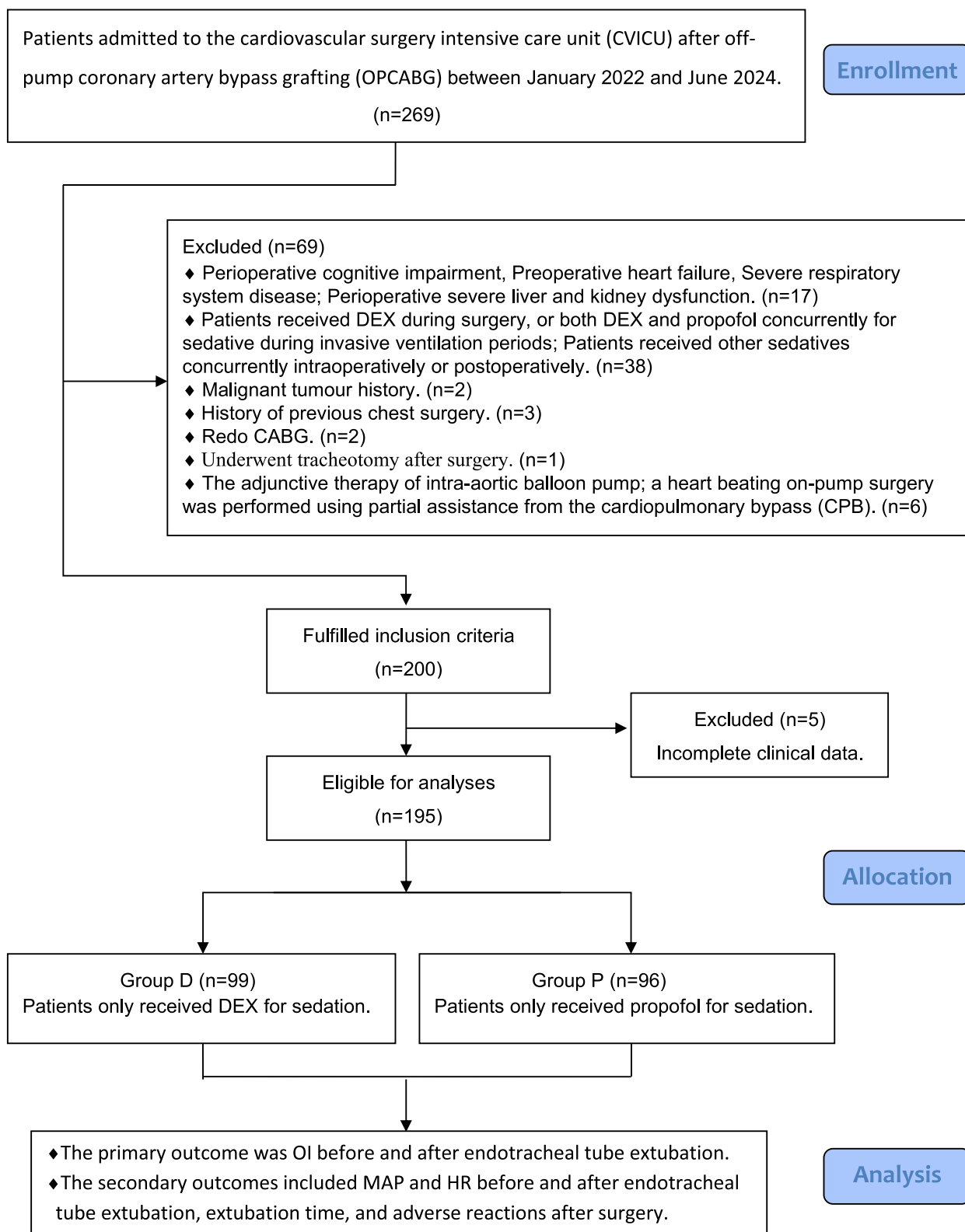
## Results

### Baseline Patient Demographic and Perioperative Characteristics

A total of 269 patients were initially identified through electronic medical records, of which 69 were excluded due to perioperative cognitive impairment, preoperative heart failure, severe respiratory system disease, etc., and 5 of them excluded due to incomplete data. The remaining 195 patients met the inclusion criteria during the enrollment period and were included in the final analysis. Of these, 99 patients received DEX and 96 received propofol for sedation during invasive ventilation after OPCABG (Figure 1). The two groups had statistically similar baseline characteristics, including age, sex, BMI, NYHA classification, ASA, hypertension, LVEF, valvular disease, atrial fibrillation, CAD classification, COPD, asthma, OSA, PO<sub>2</sub>, smoking history, cerebrovascular disease, diabetes, Cr, preoperative hemoglobin, postoperative hemoglobin, number of diseased vessels, duration of anesthesia, duration of surgery, OI before surgery and before extubation, and MAP and HR before and after surgery (Table 1).

### Postoperative Outcomes

DEX administration was significantly associated with an increased likelihood of OI before and after extubation composed to propofol (*P* < 0.05) (Table 2) (Figure 2). However, there was no statistically significant difference in the OI before and after surgery between the groups (*P* > 0.05) (Table 2) (Figure 2). MAP and HR after extubation were significantly higher than before extubation in Group P (*P* < 0.05). However, there were no significant differences between before and after extubation in Group D. Furthermore, MAP and HR were significantly lower in Group D than in Group P before and after extubation (*P* < 0.05) (A-B, Figure 3). In addition, the extubation time was remarkably shorter in Group D in comparison of propofol (*P* < 0.05) (Figure 4).



**Figure 1** Flow chart of patient screening and selection process. Group D, postoperative mechanical ventilation using only DEX for sedation; Group P, postoperative mechanical ventilation using only propofol for sedation.

**Abbreviations:** DEX, dexmedetomidine; OI, Oxygenation index.

**Table 1** Demographic Data and Patient Characteristics in the Groups

Variable	Group D (n=99)	Group P (n=96)	P value
Age, (year)	66.7±4.3	67.1±4.5	0.564
Male sex, n (%)	65 (56.7)	68 (70.8)	0.438
Weight (kg)	63.2±9.1	66.7±9.1	0.058
BMI (kg/m <sup>2</sup> )	23.7±2.9	23.9±2.7	0.561
ASA grade, n (%)			
III	92 (92.9)	93 (96.9)	0.355
IV	7 (7.1)	3 (3.1)	
NYHA classification (n, %)			
II	21(21.2)	12(12.5)	0.080
III	72(72.7)	82(85.4)	
IV	6(6.1)	2(2.1)	
Hypertension (n, %)	12(12.1)	18(18.8)	0.200
LVEF (%)	55(8)	54(7)	0.158
Valvular disease (n,%)	8(8.1)	12(12.5)	0.309
Atrial fibrillation (n,%)	13(13.1)	9(9.4)	0.407
COPD (n,%)	15(15.2)	7(7.3)	0.083
Asthma (n,%)	6(6.1)	3(3.1)	0.498
OSA (n,%)	3(3.0)	5(5.2)	0.493
PO2 (mmHg)	82.3±7.5	82.9±8.4	0.598
Smoking history, n (%)	15(15.2)	9(9.4)	0.220
Cerebrovascular disease (n, %)	11(11.1)	17(17.7)	0.189
Diabetes (n, %)	7(7.1)	15(15.6)	0.059
Cr (μmol/L)	82.8±22.4	81.5±23.4	0.689
Preoperative hemoglobin (g/L)	129.2±17.4	134.0±18.2	0.063
Postoperative hemoglobin (g/L)	105.6±13.2	107.6±10.8	0.250
Number of diseased vessels (n, %)			
1	2(2.0)	1(1.0)	0.346
2	16(16.2)	20(20.8)	
3	66(66.7)	67(69.8)	
4	14(14.1)	6(6.3)	
5	1(1.0)	2(2.1)	
CAD classification (n, %)			
Stable angina	91(91.9)	89(92.7)	0.586
Unstable angina	5(5.1)	6(6.3)	
AMI	3(3.0)	1(1.0)	
Duration of anesthesia (min)	352.6±40.3	348.1±46.9	0.468
Duration of surgery (min)	310.1±39.3	305.1±44.1	0.598

**Notes:** Data are presented as mean ± SD, median (IQR), or n (%). The quantitative data were compared using independent-sample t-tests or Mann–Whitney *U*-tests, and categorical data were compared using the chi-squared test.

**Abbreviations:** AMI, acute myocardial infarction; ASA, American Society of Anesthesiologists; BMI, body mass index; CAD, coronary artery disease; COPD, chronic obstructive pulmonary disease; Cr, creatinine; NYHA, New York Heart Association; LVEF, left ventricular ejection fraction; OSA, obstructive sleep apnea; PaO<sub>2</sub>, partial pressure of arterial oxygen; SD, standard deviation; P, probability; IQR, interquartile range.

The MCID for the OI was ultimately determined to be 20.2 mmHg. ROC analysis demonstrated a sensitivity of 100% and specificity of 9.3% for predicting the need for non-invasive mechanical ventilation after extubation (AUC=0.978,  $p < 0.001$ ). Although Group D exhibited a significantly higher OI than Group P (mean difference=18 mmHg after extubation, mean difference=10 mmHg before extubation), this difference did not exceed the predefined MCID threshold (20.2 mmHg).

**Table 2** OI Before and After Surgery in the Groups

Variable	Group D (n=99)	Group P (n=96)	P value
Before surgery	392.1±35.9	394.9±40.0	0.598
After surgery	400.8±26.8	402.2±30.3	0.748
Before extubation	389.8±17.3	379.8±27.8	0.003
After extubation	385.5±29.3	367.5±30.2	<0.001

**Notes:** Data are presented as mean ± SD. The quantitative data were compared using independent-sample t-tests.

## Postoperative Adverse Reactions

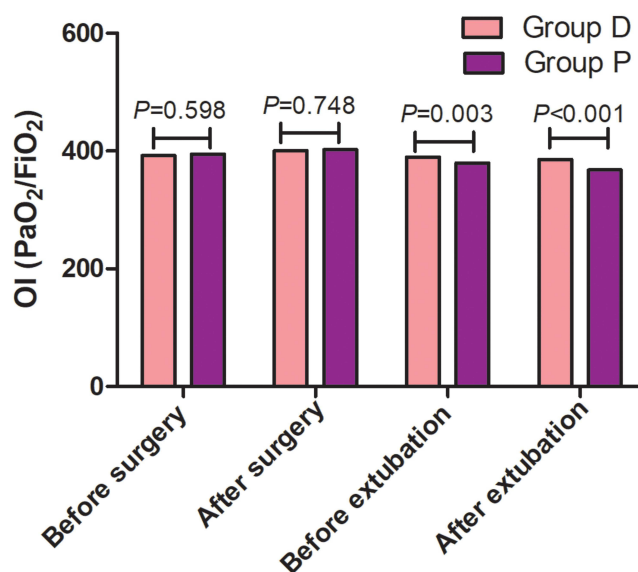
The incidence of delirium and severe cough at extubation was significantly lower in Group D than in Group P ( $P < 0.05$ ) (Table 3). However, there was no statistically significant difference between the groups with regard to the occurrence of stroke, extubation failure, new-onset arrhythmia, hypotension, bradycardia, acute kidney injury, or pneumonia ( $P > 0.05$ ) (Table 3).

## Discussion

Our study demonstrated that DEX increased the likelihood of OI before and after extubation, attenuated hemodynamic responses during extubation, reduced extubation time, and decreased the incidence of adverse reactions after OPCABG. However, there were no significant differences between before and after extubation in Group D.

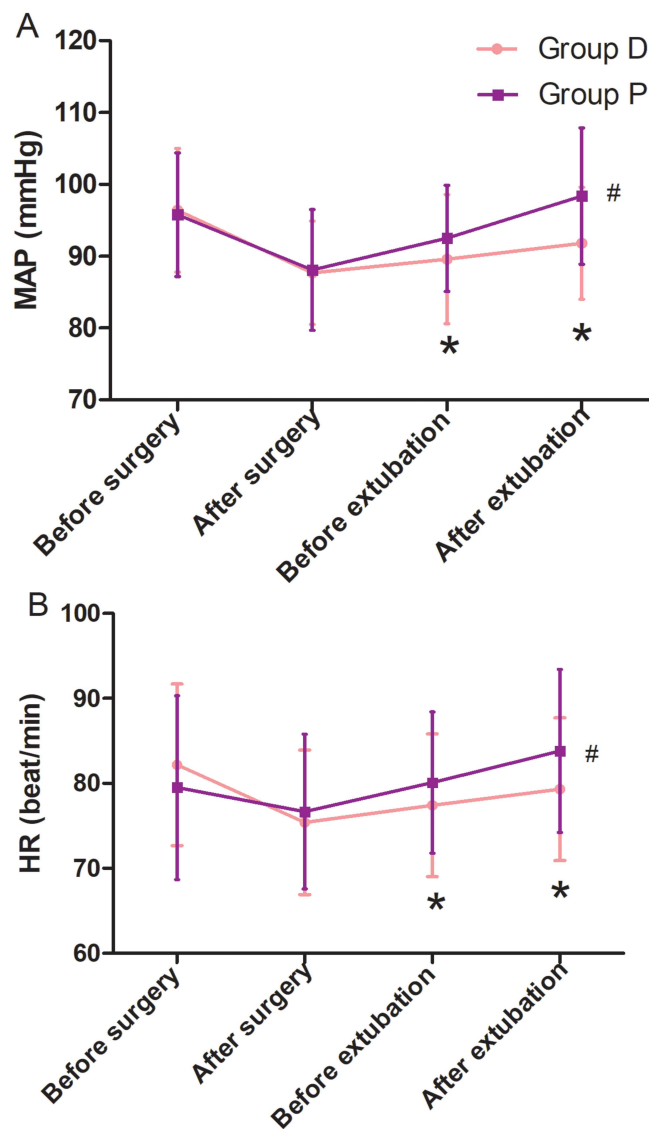
Early endotracheal tube extubation is the cornerstone of fast-track surgery after cardiac surgery and is associated with a reduction in postoperative complications, morbidity, mortality, length of stay in the ICU, and hospital costs.<sup>22</sup> In addition to the patient's heart and brain functions, recovery of lung function is a crucial phase in enhancing the success of weaning, extubation, and recovery following cardiac surgery. Horowitz et al<sup>23</sup> first described the use of OI in the assessment of pulmonary responses to acute lung injury. Since then, it has been used to quickly assess pulmonary function.<sup>24,25</sup>

This study shows that the superior OI before and after extubation in Group D was compared to that in Group P ( $P < 0.05$ ). Based on our current understanding of lung function recovery after cardiac surgery, explanations may be proposed for the observed differences in oxygenation between groups. First, DEX is a highly selective  $\alpha 2AR$  agonist widely used in clinical settings, which has been confirmed to have a protective effect on a variety of organs, including the nervous



**Figure 2** OI (PaO<sub>2</sub>/FiO<sub>2</sub>) before and after surgery between groups. OI was significantly higher in Group D compared with Group P before and after extubation ( $P < 0.05$ ). However, there was no statistically significant difference in terms of OI before and after surgery between groups ( $P > 0.05$ ), respectively. The data are given as mean ± SD, and were compared by independent-sample t-test. Group D, postoperative mechanical ventilation using only DEX for sedation; Group P, postoperative mechanical ventilation using only propofol for sedation.

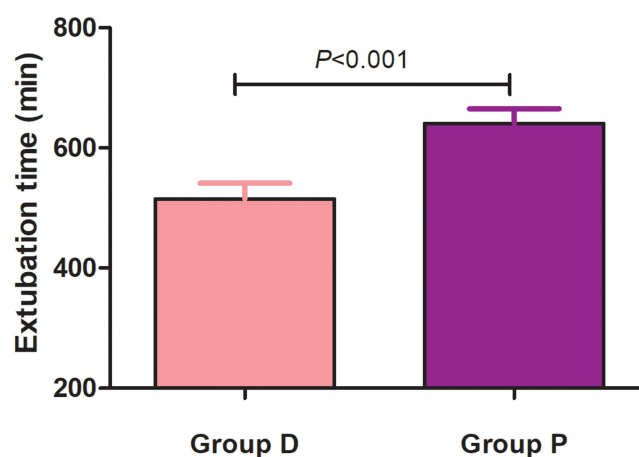
**Abbreviation:** OI, Oxygenation index.



**Figure 3** MAP before and after extubation between groups (A) HR before and after extubation between groups (B) MAP and HR after extubation were significantly higher than before extubation in Group P ( $^{\#}P < 0.05$ ), respectively. However, there was no significant difference between before and after extubation with regard to the MAP and HR in Group D ( $P > 0.05$ ). Furthermore, MAP and HR were significantly lower in Group D compared with Group P before and after extubation ( $^*P < 0.05$ ), respectively. There was no statistically significant difference in terms of MAP and HR before and after surgery between groups ( $P > 0.05$ ), respectively. The data are given as mean  $\pm$  SD. Data were compared by independent-sample *t*-test. Compared with Group P,  $^*P < 0.05$ , compared with before extubation,  $^{\#}P < 0.05$ . Group D, postoperative mechanical ventilation using only DEX for sedation; Group P, postoperative mechanical ventilation using only propofol for sedation.

**Abbreviation:** MAP, mean arterial pressure; HR heart rate.

system, heart, lungs, and so on in much clinical study and basic research. DEX acts by reducing the inflammatory response in these organs and activating anti-apoptotic signaling pathways that protect cells from damage.<sup>26</sup> The lung-protective effect of DEX is mainly achieved by reducing inflammation and pulmonary edema, inhibiting oxidative stress, and reducing apoptosis in the pulmonary tissue.<sup>27–29</sup> Second, DEX has dose-response advantages of sedation, analgesia, anti-anxiety, inhibition of sympathetic nervous system activity, and significant reduction in cardiovascular stabilization. Moreover, DEX is associated with minimal coughing, no laryngospasm/bronchospasm, stable hemodynamics, easy arousability from sedation, reduction of agitation, and delirium without causing respiratory depression.<sup>30</sup> Because of these advantages, the main organs can be fully restored. For example, the patient has a better tolerance and a more thorough suctioning phlegm, which contributes to improved gas exchange. In a systematic review and network meta-analysis, DEX was found to be the most effective medication for reducing moderate-to-severe emergence cough.<sup>31</sup> One of the most interesting targets of DEX is the prevention of multiorgan failure during surgery, trauma, or intensive care.<sup>26</sup>



**Figure 4** Comparison of the extubation time between groups. The data are given as mean  $\pm$  SD, and were compared by independent-sample t-test. The extubation time was remarkably shorter in Group D in comparison of propofol ( $P < 0.001$ ). Group D, postoperative mechanical ventilation using only DEX for sedation; Group P, postoperative mechanical ventilation using only propofol for sedation.

The results of our study revealed that DEX has a significant effect on OI, which is consistent with previous studies.<sup>11,12,32</sup> These results were further supported by Cui et al,<sup>11</sup> who found that pulmonary exudation on chest radiography was lower and pulmonary function improved in the DEX group compared to the control group after thoracoscopic cardiac surgery, which may be related to a reduction in the concentration of inflammatory cytokines in the early perioperative period. Another meta-analysis of a randomized controlled trial by Yang et al<sup>12</sup> also validated that DEX improved oxygenation in patients receiving one-lung ventilation and may additionally decrease the incidence of postoperative pulmonary complications, which may be related to the associated improvements in lung compliance, anti-inflammatory effects, and regulation of oxidative stress reactions. In a prospective controlled trial, DEX was shown to improve OI, inhibit the inflammatory response of the lungs, and thus have a certain protective effect on lung function in obese patients undergoing laparoscopic surgery under general anesthesia.<sup>32</sup>

Conversely, Elgebaly et al<sup>6</sup> found no statistically significant difference between groups D and P with regard to OI in CABG and valve replacement surgeries through standard median sternotomy and cardiopulmonary bypass (CPB) in a prospective and comparative study. This is inconsistent with the findings of our study and may be due to the following reasons: in the trial, CPB caused acute lung injury induced by multiple factors, including systemic inflammatory response, local and systemic inflammatory response syndrome (SIRS), lung I/R injury, arrest of ventilation, and circulating endotoxins in both groups. Thus, lung injury is severe and the protective action of DEX has not yet been demonstrated.<sup>33</sup> In addition, differences in surgery type, anesthesia agents, consequences of intrinsic factors, and physical condition also produced inconsistent results.

**Table 3** Adverse Reactions in the Groups (n (%))

Variable	Group D (n=99)	Group P (n=96)	P value
Delirium	2(2.0%)	9 (9.4%)	0.026
Stroke	1 (1.0%)	2 (2.1%)	0.617
Severe cough at extubation	3 (3.0%)	15 (15.6%)	0.002
Extubation failure	1 (1.0%)	3 (3.1%)	0.363
New onset arrhythmia	2 (2.0%)	4 (4.2%)	0.440
Hypotension	6(6.1%)	3 (3.1%)	0.498
Bradycardia	7 (7.1%)	5(5.2%)	0.588
Acute kidney injury	0 (0.0%)	1 (1.0%)	0.988
Pneumonia	1 (0.0)	0 (0.0%)	1.000

**Notes:** Data are presented as n (%). Categorical data were compared using the chi-squared test.

Intubation, extubation, and emergence from anesthesia are known to produce significant hemodynamic disturbances and are particularly dangerous periods for patients with ischemic heart disease, which need to avoid increases in HR and blood pressure. DEX has sedative, anxiolytic, and analgesic-sparing effects, which decrease sympathetic tone by attenuating neuroendocrine and hemodynamic responses and effectively suppressing hemodynamic reflexes to endotracheal intubation or extubation.<sup>34</sup> In this study, MAP and HR after extubation were significantly higher than before extubation in Group P ( $P < 0.05$ ). However, there were no significant differences between before and after extubation with regard to the MAP and HR in Group D ( $P > 0.05$ ). Furthermore, MAP and HR were significantly lower in Group D than in Group P before and after extubation ( $P < 0.05$ ). All of these studies showed that the hemodynamic changes before and after extubation were attenuated in Group D, and DEX may play an essential role in controlling blood pressure and HR, which contributes to alleviating the stress response and maintaining stability, and is very beneficial for the patients.

Our results are consistent with the previous outcomes conducted by Kamali et al<sup>35</sup> revealed that the benefits of DEX more than propofol in hemodynamic stability because propofol was associated with more variability in systolic/diastolic blood pressure, HR and MAP after endotracheal intubation. Sheikh et al<sup>36</sup> reported that HR and MAP were significantly lower in the DEX group than in the propofol group after open-heart surgery in a prospective, randomized controlled, double-blind clinical trial. Kunisawa et al<sup>37</sup> found a lower percentage increase in all hemodynamic parameters at skin incision or sternotomy during cardiac surgery in the DEX group than in the control group.

Early extubation after cardiovascular surgery can reduce postoperative complications, and the ideal sedative can be easily weaned from mechanical ventilation. In 2022, DEX was recommended as a sedative agent for adult patients undergoing invasive mechanical ventilation by the intensive care medicine rapid practice guidelines (ICM-RPG), which may reduce the duration of mechanical ventilation and enhance patient comfort.<sup>38</sup>

Our findings suggest that DEX may shorten the extubation time ( $P < 0.05$ ). Similarly, Abdel-Meguid<sup>39</sup> reported statistically shorter extubation times with intraoperatively administered DEX during the OPCABG. Zientara et al<sup>40</sup> revealed that DEX application supports a fast-track strategy compared with propofol in patients after OPCAB by enabling rapid extubation. Sheikh et al<sup>36</sup> demonstrated that the duration of postoperative ventilation was significantly shorter in the DEX group than that in a prospective, randomized open-heart surgery. Another retrospective cohort study reported that DEX significantly shortened the duration of mechanical lung ventilation compared to propofol during CABG surgery.<sup>41</sup> In a systematic review and meta-analysis of randomized controlled trials, DEX significantly reduced the duration of mechanical ventilation compared with propofol in cardiac surgical patients.<sup>42</sup> Nonetheless, a large multicenter PRODEX and MIDEX trial conducted by Jakob et al<sup>43</sup> indicated that DEX was non-inferior to propofol in maintaining mild-to-moderate sedation in ICU patients receiving prolonged mechanical ventilation, and could shorten the duration of mechanical ventilation. The results of these studies are in agreement with the findings of our study. The benefits of DEX on the achievement of early extubation compared to propofol could be due to the lack of an effect of DEX on the suppression of respiratory drive. Other potential reasons for the benefits of DEX sedation during early extubation include sympatholytic activity and decreased opioid requirements.<sup>44</sup>

Adverse events associated with sedatives must also be considered as they can cause hemodynamic instability, delay extubation time, produce complications, and ultimately lead to delayed postoperative recovery. From our study, we concluded that the incidence of delirium and severe cough at extubation was significantly lower in Group D ( $P < 0.05$ ). However, there was no statistically significant difference between the groups with regard to the occurrence of stroke, new-onset arrhythmia, extubation failure, hypotension, bradycardia, acute kidney injury (AKI), or pneumonia ( $P > 0.05$ ). In accordance with the previous studies by Heybati et al<sup>42</sup> and Sheikh et al.,<sup>36</sup> the risk of delirium was significantly lower in the DEX group. Interestingly, Cavallazzi et al<sup>45</sup> reported that reduced delirium with DEX may have contributed to a shorter time to extubation and earlier discharge from the ICU. Jeong et al<sup>46</sup> demonstrated that additional DEX administration reduced the incidence and severity of coughing at extubation in adults undergoing thyroidectomy in a prospective study. Intriguingly, DEX significantly reduced postoperative pulmonary complications compared with propofol in a retrospective cohort study during CABG surgery.<sup>41</sup> However, Jakob et al<sup>43</sup> revealed that DEX increased the risk of adverse reactions such as bradycardia and hypotension in patients undergoing sedation during prolonged mechanical ventilation in a multicenter, randomized, double-blind trial. A controlled trial by Soh et al<sup>47</sup> showed that preemptive DEX administration reduced the incidence of AKI after aortic surgery requiring CPB, possibly because of its sympatholytic and anti-inflammatory effects against ischemia-reperfusion injury. The incidence of hypotension, bradycardia, and AKI was also similar between the groups in this study.

## Clinical Implications

The observed between-group mean difference in OI (mean difference=18 mmHg after extubation, mean difference=10 mmHg before extubation) fell below the predefined MCID threshold of 20.2. This discordance between statistical significance and clinical relevance warrants careful interpretation. Despite the absence of definitive short-term clinical benefits, the marginal improvement in OI might indirectly enhance patient outcomes by potentially reducing postoperative complication risks. Vadi et al<sup>48</sup> reported that the odds of mortality increased by 0.853 times as the OI value decreased ( $p = 0.002$ ), in COVID-19-associated acute respiratory distress syndrome (ARDS). Additionally, Jia et al<sup>49</sup> revealed that OI measured at 6 hours of mechanical ventilation may be considered to evaluate the prognosis of patients with ARDS. Liu et al<sup>50</sup> demonstrated that OI can be used to evaluate the therapeutic efficiency, in addition to serving as a prognosis indicator, for patients with severe pneumonia. Clinical decision-making should carefully balance pharmacological safety profiles, cost-effectiveness, and individualized therapeutic requirements. Limitations include, single-timepoint OI measurements may not capturing dynamic physiological changes, potential unmeasured confounders and short-term follow-up. Future studies should evaluate longitudinal outcomes (eg, pulmonary complications, ICU length of stay) to contextualize oxygenation index changes, while concurrently exploring potential correlations between OI improvements and hard clinical endpoints (eg, organ dysfunction) to strengthen the evidence base.

## Limitations

First, this was a retrospective study, and incomplete documentation bias regarding history was added to the complexity of the study. Second, many factors can affect lung function. However, we did not record the specific dosage of anesthetic drugs, specific situations of vasoactive drugs, blood loss, types and dosages of blood products, urine volume, drainage volume, indicators of cardiac function, liver function, and renal function, all of which may have affected our research results. Third, we only analyzed MAP and HR at four time points, which is needed to observe changes in hemodynamics for more time to further confirm our research results. Finally, because our conclusions were based on a single-center study, the observational design did not allow conclusions of causality. Therefore, the findings should be considered hypothesis generating and require validation in other multicenter cohorts or randomized clinical trials to further confirm the validity of our results.

## Conclusion

Our results indicate that DEX may support satisfactory OI, good hemodynamic stability, rapid extubation time, and lower incidence of adverse reactions for sedation of mechanically ventilated patients following OPCABG surgery, although the difference with OI did not reach the MCID. Thus, we are confident of giving precedence to DEX over propofol as a new routine medication for immediate postoperative patient care. Additionally, this study may provide a rationale for further prospective clinical studies investigating the clinical benefits of DEX, including other intraoperative outcomes such as the benefits of cardiac function or renal function following surgery.

## Abbreviations

AKI, acute kidney injury; AMI, acute myocardial infarction; ASA, American Society of Anesthesiologists; BMI, body mass index; CABG, coronary artery bypass grafting; CAD, coronary artery disease; CHD, coronary heart disease; COPD, chronic obstructive pulmonary disease; CPB, cardiopulmonary bypass; CVICU, cardiovascular surgery intensive care unit; DEX, dexmedetomidine;  $FiO_2$ , fraction of inspired oxygen; HR, heart rate; ICM-RPG, intensive Care Medicine Rapid Practice Guideline; I/R, ischemia/reperfusion; IQR, interquartile range-range; LVEF, left ventricular ejection fraction; MAP, mean arterial pressure; MCID, minimal clinically important difference; NYHA, New York heart association; OI, oxygenation index; OPCABG, after off-pump coronary artery bypass grafting; OSA, obstructive sleep apnea; P, probability;  $PaCO_2$ , partial pressure of arterial dioxide;  $PaO_2$ , partial pressure of arterial oxygen; RASS, Richmond Agitation-Sedation Scale; ROC, receiver operating characteristic curve; SBT, spontaneous breathing test; SIRS, systemic inflammatory response syndrome;  $SpO_2$ , pulse oximetry saturation; SD, standard deviation;  $\alpha_2AR$ ,  $\alpha_2$  adrenergic receptor.

## Data Sharing Statement

The datasets used in this study were obtained from the corresponding authors based on reasonable requirements.

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## Author Contributions

All authors made a significant contribution to the work reported, whether in the conception, study design, execution, acquisition of data, analysis, and interpretation, or in all these areas, took part in drafting, revising, or critically reviewing the article; gave final approval of the version to be published; agreed on the journal to which the article has been submitted; and agreed to be accountable for all aspects of the work.

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## Disclosure

The authors state no conflicts of interest in this work.

## References

1. Shaefi S, Mittel A, Loberman D, Ramakrishna H. Off-pump versus on-pump coronary artery bypass grafting—a systematic review and analysis of clinical outcomes. *J Cardiothoracic Vascul Anesthesia*. 2019;33(1):232–244. doi:10.1053/j.jvca.2018.04.012
2. Gu Y, Shan L, Liu B, et al. Release profile of cardiac troponin T and risk factors of postoperative myocardial injury in patients undergoing CABG. *Int J Gen Med*. 2021;14:2541–2551. doi:10.2147/IJGM.S315691
3. Nguyen J, Nacpil N. Effectiveness of dexmedetomidine versus propofol on extubation times, length of stay and mortality rates in adult cardiac surgery patients: a systematic review and meta-analysis. *JBI Database System Rev Implement Rep*. 2018;16(5):1220–1239. doi:10.11124/JBISIRIR-2017-003488
4. Li X, Liu J, Xu Z, et al. Early identification of delayed extubation following cardiac surgery: development and validation of a risk prediction model. *Front Cardiovasc Med*. 2022;9:1002768. doi:10.3389/fcvm.2022.1002768
5. Brendle C, Mülders T, Kühn J, et al. Physiological closed-loop control of mechanical ventilation and extracorporeal membrane oxygenation. *Biomed Eng-Biomed Te*. 2017;62(2):199–212. doi:10.1515/bmt-2016-0077
6. Elgebaly AS, Sabry M. Sedation effects by dexmedetomidine versus propofol in decreasing duration of mechanical ventilation after open heart surgery. *Ann Card Anaesth*. 2018;21(3):235–242. doi:10.4103/aca.ACA\_168\_17
7. Chuich T, Cropsey CL, Shi Y, et al. Perioperative sedation in mechanically ventilated cardiac surgery patients with dexmedetomidine-based versus propofol-based regimens. *Ann Pharmacother*. 2019;53(1):5–12. doi:10.1177/1060028018793254
8. Euteneuer AA, Radosevich MA, Weingarten TN, et al. Dexmedetomidine versus propofol for postoperative recovery after cardiac surgery: a historical cohort study. *Can J Anesth*. 2024. doi:10.1007/s12630-024-02877-0
9. Ruan H, Li W, Wang J, et al. Propofol alleviates ventilator-induced lung injury through regulating the Nrf2/NLRP3 signaling pathway. *EXP MOL PATHOL*. 2020;114:104427. doi:10.1016/j.yexmp.2020.104427
10. Gu Y, Liu X, Gu T, et al. Effect of different doses of propofol on pulmonary function and inflammatory response in patients with lung ischemia reperfusion injury induced by one-lung ventilation based on big data analysis. *J Healthc Eng*. 2022;2022:7677266. doi:10.1155/2022/7677266
11. Cui J, Gao M, Huang H, et al. Dexmedetomidine improves lung function by promoting inflammation resolution in patients undergoing totally thoroscopic cardiac surgery. *Oxid Med Cell Longev*. 2020;2020:8638301. doi:10.1155/2020/8638301
12. Yang L, Cai Y, Dan L, et al. Effects of dexmedetomidine on pulmonary function in patients receiving one-lung ventilation: a meta-analysis of randomized controlled trial. *Korean J Anesthesiol*. 2023;76(6):586–596. doi:10.4097/kja.22787
13. Tang C, Li Y, Lai Y. Intraoperative dexmedetomidine for prevention of postoperative cognitive dysfunction and delirium in elderly patients with lobectomy: a propensity score-matched, retrospective study. *Int J Gen Med*. 2024;17:2673–2680. doi:10.2147/IJGM.S456762
14. Li N, Zhang Y, Yang F, et al. Effects of dexmedetomidine on oxygenation and inflammatory factors in patients undergoing uvulopalatopharyngoplasty: a prospective, randomized, placebo-controlled trial. *Sleep Breath*. 2023;27(3):1099–1106. doi:10.1007/s11325-022-02711-1
15. Kernan S, Rehman S, Meyer T, et al. Effects of dexmedetomidine on oxygenation during one-lung ventilation for thoracic surgery in adults. *J Minim Access Surg*. 2011;7(4):227–231. doi:10.4103/0972-9941.85645
16. Abe K, Shimizu T, Takashina M, Shiozaki H, Yoshiya I. The effects of propofol, isoflurane, and sevoflurane on oxygenation and shunt fraction during one-lung ventilation. *Anesth Analg*. 1998;87(5):1164–1169. doi:10.1097/00000539-199811000-00035
17. Aouad MT, Zeeni C, Al Nawwar R, et al. Dexmedetomidine for improved quality of emergence from general anesthesia: a dose-finding study. *Anesth. Analg*. 2019;129(6):1504–1511. doi:10.1213/ANE.0000000000002763
18. Guyatt GH, Osoba D, Wu AW, Wyrwich KW, Norman GR. Methods to explain the clinical significance of health status measures. *Mayo Clin Proc*. 2002;77(4):371–383. doi:10.4065/77.4.371
19. Hu G, Huang Q, Huang Z, Sun Z. Methods to determine minimal clinically important difference. *Zhong Nan Da Xue Xue Bao Yi Xue Ban*. 2009;34(11):1058–1062. PMID:19952393.
20. Kaur A, Rustagi N, Ganesan A, et al. Minimal clinically important difference of mouth opening in oral submucous fibrosis patients: a retrospective study. *J Kor Assoc Oral Max*. 2022;48(3):167–173. doi:10.5125/jkaoms.2022.48.3.167
21. van der Heijde D, Lassere M, Edmonds J, et al. Minimal clinically important difference in plain films in RA: group discussions, conclusions, and recommendations. OMERACT imaging task force. *J Rheumatol*. 2001;28(4):914–917. PMID:11327276.

22. Kumalasari RI, Kosasih CE, Priambodo AP. A scoping review of factors associated with delayed extubation in post cardiac surgery patients. *Vasc Health Risk Man.* 2025;21:1–15. doi:10.2147/VHRM.S479352
23. Horowitz JH, Carrico CJ, Shires T. Pulmonary response to major injury. *Arch Surg.* 1974;108(3):349–355. doi:10.1001/archsurg.1974.01350270079014
24. Fiser SM, Kron IL, McLendon Long S, et al. Early intervention after severe oxygenation index elevation improves survival following lung transplantation. *J Heart Lung Transpl.* 2001;20(6):631–636. doi:10.1016/s1053-2498(01)00249-2
25. Östberg E, Larsson A, Wagner P, Eriksson S, Edmark L. Positive end-expiratory pressure and emergence preoxygenation after bariatric surgery: effect on postoperative oxygenation: a randomised controlled trial. *Eur J Anaesth.* 2025;42(1):54–63. doi:10.1097/EJA.0000000000002071
26. Bao N, Tang B. Organ-protective effects and the underlying mechanism of dexmedetomidine. *Mediat Inflamm.* 2020;2020:6136105. doi:10.1155/2020/6136105
27. Fu C, Dai X, Yang Y, et al. Dexmedetomidine attenuates lipopolysaccharide-induced acute lung injury by inhibiting oxidative stress, mitochondrial dysfunction and apoptosis in rats. *Mol Med Rep.* 2017;15(1):131–138. doi:10.3892/mmr.2016.6012
28. Wu H, Tang J, Pan J, et al. Effects of dexmedetomidine on stress hormones in patients undergoing cardiac valve replacement: a randomized controlled trial. *BMC Anesthesiol.* 2020;20(1):142. doi:10.1186/s12871-020-00993-0
29. Chen M, Yan XT, Ye L, et al. Dexmedetomidine ameliorates lung injury induced by intestinal ischemia/reperfusion by upregulating cannabinoid receptor 2, followed by the activation of the phosphatidylinositol 3-Kinase/Akt pathway. *Oxid Med Cell Longev.* 2020;2020:6120194. doi:10.1155/2020/6120194
30. Salim B, Rashid S, Ali MA, Raza A, Khan FA. Effect of pharmacological agents administered for attenuating the extubation response on the quality of extubation: a systematic review. *Cureus.* 2019;11(12):e6427. doi:10.7759/cureus.6427
31. Tung A, Fergusson NA, Ng N, et al. Medications to reduce emergence coughing after general anaesthesia with tracheal intubation: a systematic review and network meta-analysis. *Brit J Anaesth.* 2020;124(4):480–495. doi:10.1016/j.bja.2019.12.041
32. Chen H, Wang X, Zhang Y, et al. Effect of dexmedetomidine on pulmonary function in obese patients undergoing laparoscopic surgery. *Perioper Med.* 2024;13(42). doi:10.1186/s13741-024-00396-6
33. Nteliopoulos G, Nikolakopoulou Z, Chow BHN, et al. Lung injury following cardiopulmonary bypass: a clinical update. *Expert Rev Cardiovas.* 2022;20(11):871–880. doi:10.1080/14779072.2022.2149492
34. Weerink MAS, Struys MMRF, Hannivoort LN. Clinical pharmacokinetics and pharmacodynamics of dexmedetomidine. *Clin Pharmacokinet.* 2017;56(8):893–913. doi:10.1007/s40262-017-0507-7
35. Kamali A, Taghizadeh M, Esfandiari M, Akhtari AS. A comparison of the effects of dexmedetomidine and propofol in controlling the hemodynamic responses after intubation: a double-blind, randomized, clinical trial study. *Open Access Maced J Med Sci.* 2018;6(11):2045–2050. doi:10.3889/oamjms.2018.385
36. Sheikh TA, Dar BA, Akhter N, Ahmad N. A comparative study evaluating effects of intravenous sedation by dexmedetomidine and propofol on patient hemodynamics and postoperative outcomes in cardiac surgery. *Anesth Essays Res.* 2018;12(2):555–560. doi:10.4103/aer.AER\_46\_18
37. Kunisawa T, Ueno M, Kurosawa A, et al. Dexmedetomidine can stabilize hemodynamics and spare anesthetics before cardiopulmonary bypass. *J Anesth.* 2011;25:818–822. doi:10.1007/s00540-011-1215-3
38. Møller MH, Alhazzani W, Lewis K, et al. Use of dexmedetomidine for sedation in mechanically ventilated adult ICU patients: a rapid practice guideline. *Intensive Care Med.* 2022;48(7):801–810. doi:10.1007/s00134-022-06660-x
39. Abdel-Meguid ME. Dexmedetomidine as anesthetic adjunct for fast tracking and pain control in off-pump coronary artery bypass. *Saudi J Anaesth.* 2013;7:6–8. doi:10.4103/1658-354X.109557
40. Zientara A, Mariotti S, Matter-Ensner S, et al. Fast-track management in off-pump coronary artery bypass grafting: dexmedetomidine provides rapid extubation and effective pain modulation. *Thorac Cardiovasc Surg.* 2019;67(6):450–457. doi:10.1055/s-0038-1668602
41. Hu J, Lv B, West R, et al. Comparison between dexmedetomidine and propofol on outcomes after coronary artery bypass graft surgery: a retrospective study. *BMC Anesthesiol.* 2022;22(1):51. doi:10.1186/s12871-022-01589-6
42. Heybati K, Zhou F, Ali S, et al. Outcomes of dexmedetomidine versus propofol sedation in critically ill adults requiring mechanical ventilation: a systematic review and meta-analysis of randomised controlled trials. *Brit J Anaesth.* 2022;129(4):515–526. doi:10.1016/j.bja.2022.06.020
43. Jakob SM, Ruokonen E, Grounds RM, et al. Dexmedetomidine vs midazolam or propofol for sedation during prolonged mechanical ventilation: two randomised controlled trials. *JAMA.* 2012;307(11):1151–1160. doi:10.1001/jama.2012.304
44. Rahman WR, Rhodes A, Grounds RM. The role of dexmedetomidine in intensive care. In: Vincent JL, editor. *Yearbook of Intensive Care and Emergency Medicine, Vol 2009.* Berlin, Heidelberg: Springer; 2009. doi:10.1007/978-3-540-92276-6\_81
45. Cavallazzi R, Saad M, Marik PE. Delirium in the ICU: an overview. *Ann Intensive Care.* 2012;2(1):49.
46. Lee JS, Choi SH, Kang YR, Kim Y, Shim YH. Efficacy of a single dose of dexmedetomidine for cough suppression during anesthetic emergence: a randomized controlled trial. *Can J Anesth.* 2015;62(4):392–398. doi:10.1007/s12630-014-0295-6
47. Soh S, Shim JK, Song JW, Bae JC, Kwak YL. Effect of dexmedetomidine on acute kidney injury after aortic surgery: a single-centre, placebo-controlled, randomised controlled trial. *Brit J Anaesth.* 2020;124(4):386–394. doi:10.1016/j.bja.2019.12.036
48. Vadi SM, Sanwalka N, Suthar D. Oxygenation index, oxygen saturation index vs PaO<sub>2</sub>/FiO<sub>2</sub> \*PEEP: a secondary analysis of OXIVA-CARDS study. *Indian J Crit Care M.* 2024;28(10):917–922. doi:10.5005/jp-journals-10071-24808
49. Jia Z, Liu X, Liu Z. Evaluation value of oxygenation index of mechanical ventilation on the prognosis of patients with ARDS: a retrospective analysis with 228 patients. *Zhonghua Wei Zhong Bing Ji Jiu Yi Xue.* 2017;29(1):45–50. doi:10.3760/cma.j.issn.2095-4352.2017.01.010
50. Liu W, Peng L, Hua S. Clinical significance of dynamic monitoring of blood lactic acid, oxygenation index and C-reactive protein levels in patients with severe pneumonia. *Exp Ther Med.* 2015;10(5):1824–1828. doi:10.3892/etm.2015.2770

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