

The Influence of Dexmedetomidine on Lung Compliance and Blood Flow Dynamics in Elder People Spinal Surgery

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Abstract: Dexmedetomidine is a new type of high selective α_2 -AR agonist with the effect of analgesia and sedation. The majority of the posterior spinal surgery should to be carried out in the prone position. Changes in body position can also lead to change in lung compliance. This kind of operation of dexmedetomidine intravenous injection on respiratory mechanics effect is not clear. This research is to observe the effect of dexmedetomidine intravenous injection with effect and cycle of lung in patients with posterior spinal surgery under general anesthesia. The study paper adopts the placebo-controlled, randomized, double-blind method. Consecutive patients were randomly divided into test group (group D) and blank group (group C). Two groups of patients were treated with intravenous anesthesia. Group D are treated with anesthesia inducing vein pump injection dexmedetomidine $0.5\mu\text{g}/\text{kg}\cdot\text{min}$ in 10minutes, maintaining the $0.05\mu\text{g}/\text{kg}\cdot\text{h}$ later. The group C pumps into the same amount of 0.9%physiological saline. We had recorded airway pressure (Ppeak) dynamic lung compliance (Cdyn) static lung compliance (Cstat), heart rate (HR) end-tidal pressure of carbon dioxide (PETCO₂) at the time of 5min before the aesthesia (T0), at the time of 5min after the anesthesia (T1), at the time of 1h after the aesthesia (T2), at the time of 2h after the anesthesia (T3). The data of two groups at different time points were statistically significant in Ppeak Cdyn HR PETCO₂ Cstat ($P<0.05$). Dexmedetomidine can significantly relieve the decrease of Ppeak, Cdyn, Cstat caused by mechanical control ventilation after the general anesthesia of the prone position surgery patients, and it can make the patients' blood pressure, heart rate and hemodynamic more stable.

Keywords: Lung compliance; Haemodynamics; Dexmedetomidine

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1. Introduction

Dexmedetomidine is a new type of high selective α_2 -AR agonist with the effect of analgesia, sedation, blocking sympathetic nerve, saving the amount of opioid drugs and anti-anxiety, providing a unique calm type in clinical use, namely "sedation keeping consciousness", and producing the result of that is similar to body's natural sleep. Although dexmedetomidine can produce comparative deep sedation in the clinical use, it has little effect on breathing, and it has the same effect even the blood drug concentration is up to 15 times of the treatment dose [1]. Other clinical effect of dexmedetomidine is also of concern, such as nerve, heart and kidney and lung protective effect. The research shows that dexmedetomidine can also through a variety of anti sympathetic, inhibit cell apoptosis [2].

In addition, it hasbeen demonstrated to reduce endotoxine-induced systemic inflammatory responses, inhibit upregulation of inflammatory cytokines, including tumor necrosis factor- α (TNF- α), interleukin-1 β (IL-1 β), IL-6 and macrophage inflammatoryprotein-2 (MIP-2); and relieve acute organ injuries in rats andpatients with sepsis [3,4]. In addition, it has been reported that dexmedetomidine has a significantly attenuated pulmonary inflammation in ventilator-induced lung injury in rat models [5].

Although the anti-inflammatory activity of dextromethorphan has been demonstrated, the mechanism of lung protection of dexmedetomidine in inflammatory molecules, including TNF- α , IL-6 and monocyte-associated cells associated with pulmonary ischemia-reperfusion injury protein (MCP) -1 is still unclear.

In the ICU, dexmedetomidine can maintain better oxygen saturation in patients undergoing intubation and extubation compared to opioids, benzodiazepines or propofol, and is successfully used for Due to emotional excitement leading to extubation failure and need to accept noninvasive ventilation in patients with emotional anxious [6]. Recent studies by Gu et al. [7] suggest that dexmedetomidine can reduce distal lung injury caused by renal ischemia-reperfusion by activating the alpha2 receptor-dependent and non-dependent mechanisms. Geze S et al. [8] showed that administration of dexmedetomidine in the pneumoperitoneum significantly reduced the production of ischemic modified albumin in lung tissue and reduced neutrophil infiltration, thereby reducing lung injury caused by pneumoperitoneum. The Mechanical ventilation can induce lung injury, especially the high tidal volume ventilation model (HVT), and administration of high doses of dexmedetomidine can significantly improve pulmonary inflammation in HVT mode and reduce pulmonary edema [9]. At the same time,

dextromethorphan can reduce the production of saliva and respiratory secretions, and further enhance its role in airway management.

2. Methods

2.1. General information

There are 60 patients with spinal posterior approach ASA I or II level, patients aged between 55~65 years old who are selected undergoing elective general anesthesia in our hospital downlink in 2015. Exclusion criteria include body mass index $>30\text{kg/m}^2$, acute or chronic respiratory disease, using β_2 agonists, hormone, isopropyl bromide amine or the ophylline drugs which are inhaled the history for nearly 2 weeks, and lung function was abnormal. The study is a placebo-controlled, randomized, double-blind, prospective study. The patients were randomly divided into test group (group D) and blank group (group C).

2.2. Anesthesia methods

To establish a peripheral venous channel, radial artery is punctured under local anesthesia monitoring arterial pressure. Anesthesia induction: after two groups of intravenous injection of sufentanil in turn $0.1\sim 0.2\mu\text{g/kg}$, propofol $1\sim 2\text{mg/kg}$, and the interaction between rocuronium $0.6\sim 0.8\text{mg/kg}$. We confirm the muscle relaxant effect. The reinforced endotracheal tube is inserted in trachea. Pipe diameter: male 7.5mm , female 7.0mm . The double lung auscultation breath sound is confirmed to be symmetrical, then we fixed tube. Catheter scale in incisors: male $22\sim 24\text{cm}$, female

$21\sim 23\text{cm}$. All of the patients after intubation used the same leonplus anesthesia machine. We control the fresh air flow 1.5L/min , the breathing rate 10 times/min, according to the ideal weight tidal volume $8\sim 10\text{ml/kg}$, to make out at the end of the CO_2 partial pressure (PETCO_2) maintained at $35\sim 40\text{mmHg}$. Intraoperative maintenance: injecting propofol $5\sim 6\text{ml/kg h}$, rocuronium 0.3mg/kg h , continuing to control infusion sufentanil plasma concentrations ($0.2\sim 0.3\mu\text{g/ml}$), stop pumping into the rocuronium, if there are 30min before end of operation.

2.3. Indicators measuring

Through the method of air monitoring each point tidal volume (VT), the airway peak pressure, PETCO_2 , dynamic lung compliance, static lung compliance change, heart rate, blood pressure by Philips M8008A multifunctional monitor (Philips company, Germany) monitoring heart rate, blood pressure changes, used anesthesia machine respiration monitoring system in the hypothesis 5min after intubation (T0), prone position 5min (T1), prone position 1h (T2) and prone position 2h (T3).

2.4. Statistical processing

The data were analyzed by SPSS 21.0 statistical software, the measurement data are mean standard deviation ($\bar{x} \pm s$), index at each time point in lung compliance within the group were compared by analysis of variance, $P < 0.05$ was considered statistically significant difference.

Table 1 Here are two groups of patients with general information and operation time (n=30)

Group	Gender F/M	Age	BMI(kg/m^2)	Operation time (t/min)
Group C	12/16	59.59 ± 7.23	21.35 ± 1.72	139.38 ± 15.42
Group D	14/19	60.25 ± 6.82	20.59 ± 1.63	138.87 ± 16.26

3. Results

Two groups of patients in the sex ratio, age, height, weight, body mass index was not statistically significant. Table 1 shows two groups of Ppeak were increased. After from supine to prone position, the test group was higher than the control group. Cdyn and Cstat were decreased after a prone position, but the experimental group was less than the control group. The two groups of data to measure the blood pressure were statistically different at different time points. There is no statistical difference in VT and PETCO_2 at each time point (Table 2).

4. Discussion

Dexmedetomidine can maintain pulmonary macrophage activity, significantly reduce lung injury objective in the inflammatory state, the function of macrophages is greatly changed, including the increase of the density of the adrenergic receptor.

Dexmedetomidine is helpful to control the inflammation, inhibit excessive activation of macrophages by macrophage activity and protection [2]. This protective effect may be alpha 2-receptor antagonists eliminate, one step closer to that of alpha 2 receptors play a protective role, and the protective effect of dexmedetomidine dose related application [10]. Lung compliance is an index reflecting the elasticity of the lung tissue. In general anesthesia with mechanical ventilation condition, dynamic lung compliance monitoring is helpful to understand the pathophysiological status of patients with respiratory system, which can prompt early airway inflammatory changes and the prevention of postoperative complications, such as pulmonary atelectasis. Therefore, it is of great significance for lung compliance monitoring during tracheal intubation process, especially in prone position surgery [11-12]. General anesthesia for spinal surgery requires

endotracheal intubation. Before the start of surgery patients need to change the position, from supine to prone position. Assume that under the general anesthesia, chest and abdomen is free, then it can improve oxygenation in prone position, but which has no effect on lung compliance [13]. Improving the mechanism of oxygenation is improving alveolar ventilation perfusion ratio in prone. Dexmedetomidine reduces alveolar pressure thereby reducing lung tissue tension. But patients will lead to increased Ppeak and Cdyn decreased, affecting the abdominal part free, abdominal pressure, diaphragmatic movement blocked,

in the prone position under general anesthesia [14-16]. Dexmedetomidine regulate norepinephrine levels, its hypnotic, sedative effect, by acting on the patients with locus coeruleus alpha 2 adrenergic receptor. Dexmedetomidine refuses injury effect on spinal dorsal horn, and achieves the effect of anti sympathetic activity in peripheral and central [17-20]. The results of this study showed that dexmedetomidine group SBP, DBP, MAP, HR is more stable. The results suggest that dexmedetomidine can reduce intraoperative adverse reactions such as blood pressure, heart rate increased.

Table 2 Here are two groups of patients with various point of time ventilation and hemodynamic parameters

Group	Case	Observation target	T0	T1	T2	T3
Group C	20	VT(ml)	486±82	486±79	480±73	471±86
		Ppeak(cmH ₂ O)	13.93±2.06	17.27±4.25 ^a	20.82±3.27	19.50±3.12
		Cdyn(ml/cmH ₂ O)	38.42±5.10	36.08±4.97 ^a	33.19±5.20 ^a	29.28±6.33 ^a
		Cstat(ml/cmH ₂ O)	48.15±7.57	45.42±8.46	42.69±7.19	37.42±8.73
		PETCO ₂ (mmHg)	35.73±2.82	35.2±2.34	35.31±2.64	35.92±2.76
		HR(min)	79.1±3.4	76.2±6.2	79.1±6.9	80.1±5.7
		MAP(mmHg)	97.4±13.6	99.6±12.5	101.3±14.2	99.5±12.4
Group D	20	VT(ml)	498±72	505±65	502±70	506±75
		Ppeak(cmH ₂ O)	14.92±2.07	18.50±3.03 ^a	18.32±3.53 ^a	18.86±3.91 ^a
		Cdyn(ml/cmH ₂ O)	38.75±5.81	36.13±4.61 ^a	34.25±4.70 ^a	31.56±5.30 ^{ab}
		Cstat(ml/cmH ₂ O)	47.81±9.8	46.41±7.32	43.56±7.02	40.32±9.32 ^{ab}
		PETCO ₂ (mmHg)	36.53±3.1	36.96±2.5	36.62±2.42	36.83±2.45
		HR(min)	78.9±3.1	62.8±5.6 ^b	63.9±6.1 ^b	65.4±5.9 ^b
		MAP(mmHg)	98.6±13.4	87.6±11.8 ^{ab}	86.8±12.1 ^{ab}	86.4±11.9 ^{ab}

Note: Compared with T0 in the same group, ^aP< 0.05; Compare with group C at the same time points, ^bP < 0.05.

5. Conclusion

That foreign animal experiments dexmedetomidine can reduce the systemic inflammatory response to endotoxin. Decreased the expression of pro-inflammatory cytokines TNF-, IL-1 and IL-6, has anti-inflammatory effect. The research shows that dexmedetomidine can also through a variety of anti sympathetic; inhibit cell apoptosis and oxidative stress and inflammatory reaction of important organs such as brain, heart, kidney, liver and lung play a protective role. Dexmedetomidine can significantly improve Ppeak control ventilation caused by anesthesia in patients with mechanical increased Cdyn, Cstat decreased, and can make the patient's blood pressure and heart rate is more stable, more stable hemodynamics, in the prone position surgery. But its protective mechanism is not clear. It is necessary to further study to provide theoretical and experimental basis for clinical effective prevention and treatment of acute lung injury.

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