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Research on the Correlation Between Anesthetic Depth and Surgical Stress Response in Minimally Invasive Cardiothoracic Surgery Anesthesia

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Abstract: Objective: To explore the relationship between anesthetic depth and surgical stress response in minimally invasive cardiothoracic surgery. Methods: A total of 89 patients who underwent thoracoscopic minimally invasive cardiothoracic surgery in our hospital from June 2024 to December 2024 were selected as the research objects. They were divided into the light anesthesia group (n = 45) and the deep anesthesia group (n = 44). The vital signs at different intraoperative nodes and perioperative stress status of the two groups were compared. *Results:* Before lesion resection and after surgery, the mean arterial pressure and heart rate of the deep anesthesia group were lower than those of the light anesthesia group, with statistically significant differences. *Conclusion:* In thoracoscopic minimally invasive cardiothoracic surgery, deep anesthesia can effectively control the patient's surgical stress response, but the postoperative awakening time is longer; patients under light anesthesia have a shorter awakening time, but the intraoperative stress response is obvious.

Keywords: Cardiothoracic surgery; Anesthetic depth; Surgical stress response; Thoracoscopic surgery

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1. Introduction

Cardiothoracic surgery is a medical specialty focusing on the diagnosis, treatment and prevention of heart and lung diseases, covering a wide range of surgical and non-surgical treatment methods, including coronary artery bypass grafting, heart valve replacement, cardiac pacemaker implantation, heart transplantation, lung tumor resection, lung transplantation, etc. Thoracoscopy is a minimally invasive surgical method with the advantages of small wound and rapid recovery, and is widely used in clinical treatment of cardiothoracic surgery. However, minimally invasive surgery may still induce intraoperative stress response in patients, increasing the risk of postoperative complications [1]. Therefore, in minimally invasive cardiothoracic surgery, it is necessary to control the intraoperative anesthetic depth to reduce damage to the patient's body, thereby reducing the stress response, further lowering the risk of minimally invasive surgery, and helping patients recover as soon as possible after surgery.

2. Materials and methods

2.1. General information

A total of 89 patients who underwent thoracoscopic minimally invasive cardiothoracic surgery in our hospital from June 2024 to December 2024 were selected as the research objects.

2.1.1. Inclusion criteria

(1) Clinically diagnosed with lung cancer and meeting the indications for thoracoscopic minimally invasive surgery [2];

(2) Aged over 18 years old;

(3) American Society of Anesthesiologists (ASA) grade I-III, stable vital signs, no allergy to anesthetics, and tolerance to surgery;

(4) Complete clinical data and voluntary participation in this study [3].

2.2. Research methods

The 89 patients scheduled for minimally invasive cardiothoracic surgery fasted and abstained from drinking before surgery. After entering the operating room, venous access was established, various monitoring instruments were connected to monitor changes in the patient's intraoperative vital signs. In addition, the operating room nurse disinfected the patient's face, accurately placed electrodes 5 cm above the nasal root, parallel to the right eyebrow arch, and at the right temple, correctly connected the BIS electrodes, and debugged the equipment parameters. Both groups of patients received mask oxygen inhalation. Midazolam, sufentanil and propofol were used as anesthetic induction drugs, and cisatracurium besylate was used as a muscle relaxant [4]. After the patient's eyelash reflex disappeared, the patient's position was changed to a lateral position with the surgical site facing up, the lung ventilation mode was switched, and one-lung ventilation was started. All patients received propofol 6–12 mg/(kg·h) combined with remifentanil 0.1–0.3 μg/(kg·min) for intraoperative anesthesia, and cisatracurium besylate was injected intermittently to maintain muscle relaxation in patients, facilitating subsequent thoracoscopic lobectomy [5]. During the operation, the patient's BIS changes were continuously monitored to ensure that the value was maintained within the range of 40–60; the patient's mean arterial pressure (MAP) was monitored. Once the arterial pressure was less than 65 mmHg, crystalloid fluid was infused rapidly. If the blood pressure still did not recover, norepinephrine was injected in a timely manner, and the dosage of norepinephrine was adjusted according to changes in blood pressure until the blood pressure was greater than 65 mmHg. After surgery, both groups of patients used patient-controlled intravenous analgesia (PCIA) pumps for analgesia, and sufentanil was used as the analgesic drug until 48 hours after surgery. The patients were asked about wound pain, breathing smoothness, etc., and postoperative indicators were monitored [6].

2.3. Observation indicators

(1) Monitor the mean arterial pressure, heart rate and blood oxygen saturation of the two groups of patients before anesthesia induction, at intubation, before lesion resection and after surgery.

(2) Compare the postoperative awakening time and extubating time of the two groups of patients, and observe the patient's consciousness, such as the ability to move the eyes and shake hands.

(3) Compare the preoperative, intraoperative and postoperative norepinephrine dosage, postoperative pain degree and postoperative analgesic drug dosage of the two groups of patients to scientifically evaluate the

impact of anesthetic depth on the patient's surgical stress response [7].

(4) Compare anesthesia-related complications between the two groups of patients, such as restlessness after awakening and postoperative delirium.

Postoperative delirium assessment includes the following indicators:

(1) Fluctuating mental state;

(2) Inattention;

(3) Confused and unclear consciousness;

(4) Disordered language expression and thinking [8].

2.4. Statistical analysis

SPSS24.0 software was used for data analysis. Independent sample *t*-test or repeated measures analysis of variance was used for intergroup comparison. Data were expressed as [n(%)], and χ^2 test was used for intergroup comparison. $p < 0.05$ was considered statistically significant.

3. Results

3.1. Comparison of vital signs of patients

There were no statistically significant differences in MAP, heart rate and blood oxygen saturation between the two groups before anesthesia induction and immediately after intubation ($p > 0.05$). Before lesion resection and at the end of surgery, the MAP and heart rate of the deep anesthesia group were lower than those of the light anesthesia group, with statistically significant differences ($p < 0.05$). See **Table 1**.

Table 1. Comparison of vital signs of patients

Indicators	Groups	n	Before anesthesia induction	Immediately after intubation	Before lesion resection	At the end of surgery
MAP/mmHg	Deep anesthesia group	45	89.23±5.29	89.15±6.73	79.32±5.24	85.34±3.16
	Light anesthesia group	44	88.63±4.36	91.32±7.25	88.35±7.21	87.34±5.62
Heart rate (beats/min)	Deep anesthesia group	45	75.21±5.84	87.03±7.25	84.30±6.12	79.35±6.16
	Light anesthesia group	44	77.61±6.21	89.33±8.74	92.15±8.34	82.30±7.69
Blood Oxygen saturation/%	Deep anesthesia group	45	98.96±2.06	95.72±2.23	94.76±3.12	95.86±2.47
	Light anesthesia group	44	98.32±1.60	98.28±2.16	95.13±2.38	96.02±2.20

3.2. Comparison of stress status of patients

Before surgery, the levels of prostaglandin E2 (PGE2), nerve growth factor (NGF) and substance P (SP) in the blood of the two groups were balanced, with no statistically significant differences ($p > 0.05$). At the end of surgery and 1 day after surgery, the levels of PGE2, NGF and SP in the deep anesthesia group were lower than those in the light anesthesia group, with statistically significant differences ($p < 0.05$). See **Table 2**.

Table 2. Comparison of stress status of patients

Indicators	Groups	n	Before surgery	At the end of surgery	1 day after surgery
MAP/mmHg	Deep anesthesia group	45	172.34 ± 19.14	219.84 ± 32.05	200.05 ± 27.38
	Light anesthesia group	44	174.43 ± 20.20	261.40 ± 35.36	240.15 ± 29.61
Heart rate (beats/min)	Deep anesthesia group	45	316.45 ± 31.64	362.10 ± 36.36	347.95 ± 33.64
	Light anesthesia group	44	322.61 ± 35.80	402.39 ± 40.15	395.78 ± 32.41
Blood Oxygen saturation/%	Deep anesthesia group	45	10.21 ± 1.34	23.72 ± 2.73	17.54 ± 3.24
	Light anesthesia group	44	10.05 ± 1.66	26.90 ± 4.21	21.25 ± 2.39

4. Discussion

4.1. Correlation between anesthetic depth and surgical stress response in minimally invasive cardiothoracic surgery

With the wide application of minimally invasive surgery in cardiothoracic surgery treatment, the treatment methods of cardiothoracic surgery have become more diversified, which has gradually reduced the trauma caused by surgery to patients' bodies, and provided treatment opportunities for many patients with poor physical function who cannot accept conventional surgery, thereby helping them alleviate pain and recover health. Anesthesia is an important part of minimally invasive cardiothoracic surgery and an important factor affecting the patient's surgical stress response [9]. Therefore, cardiothoracic surgeons should strengthen cooperation with anesthesiologists to determine the anesthetic depth and anesthetic dosage according to the patient's physical condition, surgical time and difficulty, laying a good foundation for minimally invasive surgery. This study showed that the blood pressure of the deep anesthesia group was significantly lower than that of the light anesthesia group during and after thoracoscopic minimally invasive surgery, and the hemodynamics was relatively stable. Under deep anesthesia, the patient's myocardial activity is inhibited, the heart rate gradually slows down, and the blood pressure decreases, which is conducive to alleviating the patient's intraoperative stress response. However, if the patient's blood pressure is lower than 65 mmHg, the anesthetic risk will increase, threatening the patient's life safety. Under light anesthesia, the patient's cerebral cortex is relatively active, and the inhibition of myocardial activity is not obvious, so the heart rate and blood pressure are higher than those of patients under deep anesthesia, which may lead to postoperative pain [10]. In addition, this study believes that elderly patients face higher anesthetic risks in minimally invasive cardiothoracic surgery. Deep anesthesia should be used with caution, the dosage and administration rate of propofol should be strictly controlled, and the blood pressure and heart rate of elderly patients should be closely monitored during the operation to reduce the patient's surgical stress response.

4.2. Impact of surgical stress response on the prognosis of minimally invasive cardiothoracic surgery

This study believes that reducing the patient's surgical stress response can not only help the patient's postoperative rehabilitation, but also improve the long-term prognosis [11]. Under the surgical stress state, the synthesis and release of prostaglandin E2 (PGE2), nerve growth factor (NGF) and substance P (SP) in the blood of the two groups of patients will increase, which will promote the growth and differentiation of neurons, and invisibly aggravate the growth of inflammatory factors in the patient's body after surgery. At the same time, this study showed that the levels of PGE2, NGF and SP in the deep anesthesia group were significantly lower than those in the light anesthesia group at the end of surgery and 1 day after surgery, indicating that deep anesthesia can effectively inhibit the patient's surgical stress response and avoid postoperative inflammatory response. In addition, this study selected remifentanil combined with propofol as the anesthesia maintenance plan. Remifentanil has a better analgesic effect, which can effectively inhibit the patient's myocardial activity, thereby reducing the patient's surgical stress response; the combination of remifentanil and propofol can improve the sedative and hypnotic effect and effectively inhibit the patient's surgical stress response [12].

4.3. Deep anesthesia effectively controls patients' stress levels

This study found that the level of inflammatory factors in the deep anesthesia group was higher than that in the light anesthesia group, indicating that light anesthesia has a relatively low impact on the patient's body's inflammatory level. This study used propofol combined with remifentanil for deep anesthesia, which can effectively reduce the inflammatory damage caused by stress response, while light anesthesia can effectively reduce the risk of postoperative delirium in patients [13].

4.4. Suggestions for improving patients' comfort during anesthesia in minimally invasive cardiothoracic surgery

First, anesthesiologists can use antibacterial dressings to cover the deep vein puncture site, reduce the entry of sweat and blood into the puncture site during minimally invasive surgery, minimize the production of bacteria at the puncture site, reduce the probability of puncture site infection, and help the healing of the patient's wound. At the same time, anesthesiologists should do a good job in disinfection before deep vein puncture and antibacterial protection of the puncture site, laying a good foundation for subsequent surgery. Second, postoperative pain is one of the important problems to be solved in minimally invasive cardiothoracic surgery, and it is also an important factor affecting the patient's postoperative recovery [14]. After surgery, anesthesiologists can take measures such as paravertebral nerve block and analgesic pumps to block nerve transmission by local injection of anesthetic drugs, thereby reducing postoperative pain in patients. For example, in thoracoscopically guided minimally invasive surgery, anesthesiologists can carry out postoperative pain management according to the patient's consciousness and vital sign monitoring data after surgery, reduce the patient's dependence on general anesthetics, and help the patient recover as soon as possible.

5. Conclusion

In conclusion, minimally invasive surgery provides more treatment options for patients and promotes the development of clinical treatment of cardiothoracic surgery. In minimally invasive cardiothoracic surgery, anesthetic depth is an important factor affecting the patient's surgical stress response, which will affect the patient's intraoperative blood pressure, heart rate, postoperative inflammatory level and postoperative rehabilitation effect. Therefore, cardiothoracic surgeons should attach importance to the anesthesia management of minimally invasive surgery, strengthen cooperation with anesthesiologists, formulate anesthesia plans according to preoperative evaluation and surgical plans, clarify the anesthetic depth, and strictly control the dosage and administration rate of anesthetic drugs. Patients under light anesthesia can wake up as soon as possible after surgery, with mild inflammatory response in the body, but obvious postoperative pain and stress response [15]. Patients under deep anesthesia have relatively slow intraoperative hemodynamics and obvious surgical stress response, but abnormal changes in postoperative blood pressure and heart rate, delayed awakening time, and obvious inflammatory response. Therefore, in the clinical work of minimally invasive cardiothoracic surgery, attending physicians and anesthesiologists should comprehensively evaluate the patient's physical state and surgical plan, select an appropriate anesthetic depth; optimize the combined use of anesthetic drugs and administration rate, reduce the role of analgesic drugs in surgical inflammatory stress, improve the anesthetic effect, and help patients recover as soon as possible.

Disclosure statement

The authors declare no conflict of interest.

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