Comparison of effects of transversus abdominis plane block and thoracic epidural anesthesia mediated activation of inflammasome on postoperative medication, pain, and recovery in patients undergoing laparoscopic colorectal surgery

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Abstract. – OBJECTIVE: This work was developed to compare the effects of transversus abdominis plane block (TAPB) and thoracic epidural anesthesia (TEA) mediated activation of inflammasome on postoperative medication, pain, and recovery in patients undergoing laparoscopic colorectal surgery. Then, the effects of two anesthesia methods on postoperative analgesia of patients were investigated and compared, aiming to provide reference for the selection of postoperative analgesia methods of laparoscopy.

PATIENTS AND METHODS: In this work, patients undergoing laparoscopic colorectal surgery were rolled into a TAPB group (30 patients) and a TEA group (30 patients). The blood pressure and stress indexes of the patients at different time points were observed and compared, and the doses of anesthetic drugs were recorded. Postoperative pain scores were evaluated, and postoperative recovery of the two groups was compared. Meanwhile, the peripheral venous bloods were extracted from the two groups before and after surgery for the determination of inflammasome proteins, and the detection results were compared.

RESULTS: Data showed that the dose of sufentanil in TEA group was notably inferior to that in TAPB group ($p<0.05$). The blood pressure indexes in the TEA group decreased remarkably ($p<0.05$), while their changes in the TAPB group were stable. The slower point heart rate (HR), lower mean arterial pressure (MAP), and lower levels of cortisol (Cor) and norepinephrine (NE) in the TEA group were found when compared with the TAPB group during the period from pneumoperitoneum establishment to post-ventilation. After pneumoperitoneum establishment, blood oxygen saturation (SpO_2) in the TEA group was lower than that in the TAPB group at the same time point ($p<0.05$). The postoperative visual analog scales (VAS) score and numerical rating scale (NRS) score in TEA group were lower than those in TAPB group ($p<0.05$). After surgery, the protein level in TEA group was significantly lower than that in TAPB group ($p<0.05$).

CONCLUSIONS: In short, the activation of inflammasome mediated by TEA could reduce the anesthetic agents used after laparoscopic colorectal cancer surgery and reduce the surgical stress response. In addition, TEA exerted a little effect on early immunity, which was safe and feasible, contributing to postoperative analgesia and recovery. In addition, its application value in laparoscopic postoperative analgesia was higher than TAPB.

Key Words:

Transversus abdominis plane block (TAPB), Thoracic epidural anesthesia (TEA), Mediated inflammation, Laparoscopic colorectal surgery, Postoperative laparoscopic analgesia.

Introduction

Today, laparoscopic colorectal surgery is a minimally invasive procedure that is primarily used in the diagnosis and treatment of rectal cancer. Though it is minimally invasive, patients will still feel pain during the operation. If the condition is severe, the pain will even double, bringing physical and mental harm to patients1. During the laparoscopic colorectal surgery, tool stimulation and artificial pneumoperitoneum pressure will induce sympathetic nerve excitation. It then pro-

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motes the spasmodic contraction of mesenteric blood vessels and intestinal smooth muscle, causing ischemic pain and injury to patients[2]. Multi modal analgesia strategy (MMAR) combines various analgesic agents and technical methods[3]. Through research, the MMAR is to reduce the sympathetic excitation, promoting patients to get out of bed in advance, inducing anal exhaust, promoting systemic blood circulation, and accelerating intestinal peristalsis. The gastrointestinal function of patients undergoing laparoscopic colorectal surgery is recovered in advance and postoperative healing is accelerated[4]. This mode of postoperative laparoscopic analgesia includes two schemes, one is transversal abdominis plane block (TAPB), the other is thoracic epidural anesthesia (TEA).

TAPB produces analgesic effects on the skin, muscle, and parietal peritoneum of the anterior abdominal wall[5]. Today, TAPB, as a new analgesic technique, has gained clinical approval due to its easy-to-learn, simple operation, and few adverse reactions. It is often used for analgesia in various laparoscopic surgeries to reduce the dependence on opioids and postoperative pain. However, the blocking range of TAPB is limited, and it can't well relieve the visceral pain of patients, showing restricted applications[6]. TEA can overcome the limitation of TAPB. It can relieve the pain sensation caused by laparoscopic surgery and remit the visceral pain, and it is widely used in postoperative analgesia of rectal surgery being the best postoperative analgesic choice[7]. However, with the rapid development and research of minimally invasive surgery nowadays, TEA has also been clinically questioned due to some rarely occurring but very serious adverse reactions[8].

Currently, there are still doubts about the applications of TAPB and TEA in postoperative analgesia for laparoscopic colorectal surgery. Most of these controversies are about the comprehensiveness of the block, the effect of postoperative analgesia, and the effect of patient recovery. The study of Zhou et al[9] showed that TEA, as an analgesic method after laparoscopic surgery, had a significant effect on alleviating patients' pain; however, it also caused many adverse reactions due to the technical and management deficiencies during and after the surgery. Zhong et al[10] found that TAPB could inhibit the introduction of nociceptive stimuli and relieve wound pain; still it showed limited clinical application because of its complicated operation, and some individuals suffered from visceral pain and local analgesia after surgery[10]. Inflammasome is one of the immune sensing and activation signaling pathways mainly found in macrophages in recent years. Pathogenic signal molecules are sensed by inflammasome, and inflammasome aggregates to activate inflammatory caspase-1, thus leading to the maturation and secretion of inflammatory factors. Inflammatory factors are potential factors causing fever, pain, and inflammation. Peripheral inflammatory factors can induce hypersensitivity to pain or to heat pain from nerve endings. The formation and activation of NOD-like receptor thermal protein domain associated protein 3 (NLRP3) inflammasome is required for the release of inflammatory factors by immune active cells in the body. Therefore, the objective of this work was to compare the effects of TAPB and TEA mediated activation of inflammasome on postoperative medication, pain, and recovery in patients undergoing laparoscopic colorectal surgery. In this way, the effects of two anesthesia methods on postoperative analgesia of patients were explored, hoping to provide reference for the selection of postoperative analgesia methods of laparoscopy.

Patients and Methods

Research Objects

Sixty patients who underwent laparoscopic colorectal surgery in Fudan University from January 2020 to April 2021 were selected. This experiment had been approved by the Ethics Committee of the Hospital and informed consent had been signed with the patients and their families.

Inclusion Criteria

Subjects were included in the study if: (I) they were 20 to 70 years old; (II) they underwent laparoscopic colorectal surgery and were pathologically diagnosed as colorectal cancer; (III) American Society of an Anesthesiologists Classification (ASA) grade I-II11; (IV) body mass index (BMI) of patients ranged from 17.9 to 31.2 kg/m^2; (V) functions of heart, liver, kidney, and lung were basically normal; (VI) epidural block or transverse abdominis plane block was selected according to the patient's condition and wishes; (VII) the case data of patients were completed.

Exclusion Criteria and Discontinuation Criteria

Patients with (I) abnormal coagulation function, (II) systemic metabolic diseases, (III) organic dysfunction of heart, liver, kidney, and lung; (IV) with diseases of the nervous or mental system, (V) allergic constitution, (VI) or with other diseases affecting the test results, were excluded from the study. Moreover, were excluded (VII) pregnant or lactating women, and (VIII) patients with incomplete clinical data.

Discontinuation criteria: if serious adverse reactions occurred, the experiment must be discontinued after comprehensive decision of the subjects or researchers.

The Main Reagents and Instruments

Equipment: Datex-Ohmeda Aespire anesthesia machine was from Guangxi Changhong Pharmaceutical Co., Ltd, Guangxi, China. PHILIPS vital signs monitor was from Siemens AG, Germany. Electroencephalogram dual-spectrum measurement monitor was from Chongqing Optec Instrument Co., Ltd, China. LION dual-channel microsyringe pump was from Thermo Company, USA. Wisonic color Doppler ultrasound system was from Wuhan Medical Device Factory, China. Disposable central venous catheter kit was from Ningbo Jiangnan Instrument Factory, China. Microcomputer electronic analgesic pump was from Olympus Corporation, Japan.

Reagents: ropivacaine hydrochloride injection was from Sinopharm Chemical Reagent Co., Ltd., China. Etomidate injection was from Shanghai Gefan Biotechnology Co., Ltd, China. Atracurium cisbesilate was from Shanghai New Asia Pharmaceutical Co. Ltd, China. Sufentanil injection was from Tianjin Bomei Biotechnology Development Co., Ltd, China. Remifentanil citrate injection was from Sinopharm Chemical Reagent Co. Ltd, China. Parecoxib sodium was from Shanghai Sinopharm Group Chemical Reagent Co. Ltd, China. Atropine sulfate injection was from BASF AG, Germany. Midazolam injection was from Sinopharm Chemical Reagent Co. Ltd, China. Neostigmine methosulfate injection was from Guangxi Changhong Pharmaceutical Co., Ltd, China.

The Experimental Methods

Case grouping

All subjects who met the inclusion criteria were numbered and randomly divided into a TEA group (n=30) and a TAPB group (n=30) in a 1:1 ratio by using a computer-generated random number table. There was no considerable difference in general data between the two groups (p>0.05).

Anesthesia, surgery, and postoperative pain relieving methods

Patients in the TEA group were admitted to the room and received TEA under routine monitoring. The time points T0 to Tx were selected, and the tube was placed 5 cm towards the head end. After it was confirmed that the epidural tube was in the epidural space, 0.375 ropivacaine was added successively to about 9 mL. After bispectral index (BIS) was monitored, propofol (plasma target concentration of 3 mg/L), remifentanil (plasma target concentration of 3.5 ng/mL), and cisatracurium (0.28 mg/kg) were successively induced under general anesthesia. 4.5 mL of 0.375% ropivacaine was added epidurally 1h after the interval. Before surgery, 0.1 g flurbiprofen axetil injection was given intravenously. After surgery, the patients were given 4 mg tropisetron and fentanyl (1.5 g/kg) and sent to the recovery room for anesthesia and recovery. After surgery, the patient was given an epidural analgesia pump to continuously pump 3.5 mL 0.2 ropivacaine, 3.5 mL patient-controlled analgesia (PCA), and the locking time was half an hour.

Patients in the TAPB group received TAPB under routine supervision after admission. After local anesthesia, intraplane ultrasound technology was used to place the puncture needle slowly into the transverse abdominal muscle and the internal oblique muscle and transfer it to the thoracolumbar fascia. Then, a small amount of physiological saline solution was injected to determine the position of the needle tip. The anesthesia block level was measured 25 minutes after bilateral block, and the induction and maintenance plans were the same as thosein the TEA group. 0.1 mg/L 0.375 ropivacaine on each side was added at an interval of 2 h. After surgery, the patients were given 5 mg tropisetron and 2 g/L fentanyl and sent to the recovery room for anesthesia and recovery. After surgery, the patient was given an epidural analgesia pump to continuously pump 3.5 mL 0.2 ropivacaine, 3.5 mL PCA, and the locking time was half an hour.

Patients in the TAPB group received TAPB under routine supervision, and anesthesia induction was performed with 1-1.5 mg/kg propofol, 0.1-0.3 μg/kg sufentanil, and 0.1-0.3 mg/kg cisatracurium. Maintenance anesthesia was implemented by 4-10 mg/(kg·h) propofol, 1-2% inhalation of sevoflurane, 0.2-0.3 μg/kg remifentanil per minute, and 1-2 μg/kg cisatracurium. The 730 color Doppler ultrasound diagnostic instrument and auxiliary probe (6-13 MHz) (GE, USA) were used to scan the leading edge of latissimus dorsi muscle, backyard of external oblique muscle, and triangular region formed by iliac crest of the patient. The doctor held the right hand to puncture the region. If the needle tip touched the correct position and there was no blood return after extraction, 2 mL physiological saline could be injected. Another 20 mL 0.375% ropivacaine hydrochloride was injected, and the contralateral block was performed with the same method.

Observation time points and indicators

a) The systolic blood pressure (SBP), diastolic blood pressure (DBP), and heart rate (HR) of patients in both groups were recorded before anesthesia (T0), when pneumoperitoneum was established (Tx), after pneumoperitoneum was established (Ty), after aeration (Tz), 1h after surgery (T1), 6h after surgery (T2), 24h after surgery (T3), and 48h after surgery (T4).

b) Dosage of anesthetic drugs: sufentanil consumption at each time point 1h (T1), 6h (T2), 24h (T3), and 48h (T4) after surgery was recorded for two groups.

c) Stress indicators: arterial HR and mean arterial pressure (MAP) were analyzed before anesthesia (T0), at the establishment of pneumoperitoneum (T1), after the establishment of pneumoperitoneum (T2), and after ventilation (T3), so did the oxygen saturation (SpO_2), cortisol (Cor), norepinephrine (NE), and preoperative and postoperative stress indexes superoxide dismutase (SOD) and maleic dialdehyde (MDA).

d) Visual analogy scale (VAS) score and numerical rating scale (NRS) score were recorded at resting and exercise at 1h (T1), 6h (T2), 24h (T3), and 48h (T4) after surgery to evaluate the severity of postoperative pain.

e) The first press time of the analgesia pump, the anal exhaust time, the first time of getting out of bed, the satisfaction score of postoperative analgesia (0=dissatisfied, 10=very satisfied), and the incidence of postoperative adverse reactions such as nausea, vomiting, dizziness, and pruritus were recorded.

NLRP3 inflammasome laboratory test

2 mL of fasting peripheral blood was taken from all patients within 24h after admission and 72h after surgery in the morning, and the blood was left at room temperature for 20 minutes. 100μL ethylenediamine tetraacetic acid (Qihua Chemical Co., LTD., Guangdong, China) was taken for anticoagulation, and 200μL erythrocyte lysate was added. The supernatant was collected, and the protein concentration was determined using a bromochloroacetic acid (BCA) kit (Yiyan Biotechnology Co., LTD., Shanghai, China) for vertical electrophoresis separation. The protein was then transferred to a blocking solution containing 10% skim milk powder (Dongju Biotechnology Co., LTD., Jiangsu, China) and placed overnight at 4°C. NLRP3 monoclonal antibody (Cell Signalling Technology, USA) was added and left to rest at room temperature for 4h. After washing, the diluted horseradish peroxidase labeled anti-rat secondary antibody was added, left at room temperature for 1h, and washed thoroughly. Bandscan software (Glyko, Novato, CA, USA) was used for semi-quantitative analysis to determine the IOD values of each strip.

Statistical Analysis

SPSS 24.0 (IBM Corp., Armonk, NY, USA) was employed for data statistics and analysis. Mean ± standard deviation ($\bar{x}\pm s$) was how measurement data were expressed, and the *t*-test was used to analyze the data, the test level was $\alpha=0.05$, and $p<0.05$ was statistically significant.

Results

Changes in Blood Pressure of the Two Groups of Patients at Different Time Points

Figure 1 and Figure 2 showed the changes in blood pressure in the TEA group and TAPB group at different time points. Compared with the values at T0, the SBP and DBP in the TEA group from T1 to T4 showed a downward trend, and the decrease was substantial ($p<0.05$), while those in the TAPB group from T1 to T4 were not remarkably reduced, and the difference between the two was not statistically substantial ($p>0.05$). Then, the blood pressures in the TEA group and the TAPB group were compared, it was found that the blood pressure change of the TAPB group was relatively stable, and the amplitude was not large.

Comparison of Anesthetic Drug Consumption

The postoperative sufentanil consumption changes of the two groups of patients were shown in Figure 3. The consumption of sufentanil in the TAPB group was dramatically superior to that in the TEA group at T1 and T2 after the surgery, and there was a considerable difference between the two ($p<0.05$). The consumption of sufentanil at T3 and T4 of the two groups of patients was basically similar, and there was no considerable difference between the two ($p>0.05$).

Comparison of Stress Indicators

The MAP, SpO_2, Cor, NE, and HR of patients in both groups were recorded at T0, Tx, Ty, and Tz. Preoperative and postoperative SOD and MDA were measured and analyzed. The above indexes were used as stress indexes for comparative analysis.

Figure 4 showed the changes in MAP of the two groups of patients. The MAP of the patients in the TEA group was remarkably higher at Ty than at T0 ($p<0.05$). The MAP of patients in the TAPB group was dramatically superior to at T0 during Ty-Tz ($p<0.05$). The comparison of MAP between the two groups showed that the TEA group was remarkably smaller than in the TAPB group at Ty and Tz ($p<0.05$).

Figure 5 showed the changes in SpO_2 in the two groups of patients. The SpO_2 of the patients in the TEA group was remarkably higher at T2 than at T0 ($p<0.05$). SpO_2 at Ty in TAPB group was dramatically superior to that at T0 and Tx ($p<0.05$). The SpO_2 in the TEA group at Ty was notably inferior to that in the TAPB group at the same time point ($p<0.05$).

Figure 6 showed the changes in Cor of the two groups of patients. Cor in the TEA group was remarkably higher at T2 than that at T0 ($p<0.05$). Cor in the TAPB group was dramatically superior to the T0 during Ty-Tz ($p<0.05$). It was concluded that in the Ty-Tz time period, the Cor in the TEA group was remarkably smaller than that in the TAPB group ($p<0.05$).

Figure 7 showed the changes in NE of the two groups of patients. The NE of patients in the TEA group was remarkably higher at the T2 time point than at T0 ($p<0.05$). The NE in the TAPB group was dramatically superior to the T0 time point during Ty-Tz ($p<0.05$). Comparison of the NE of the two groups of patients showed that in the Ty-Tz time period, the TEA group was remarkably smaller than the TAPB group ($p<0.05$).

Changes in HR of the two groups of patients were illustrated in Figure 8. The HR of patients in the TEA group was remarkably faster at T2 than that at T0 ($p<0.05$). The HR of patients in the TAPB group was dramatically superior to the T0 during Ty-Tz ($p<0.05$). Comparison of the HR of the two groups of patients showed that in the Ty-Tz, the TEA group exhibited a remarkably slower HR than the TAPB group ($p<0.05$).

Figures 9 and 10 showed the changes in SOD and MDA of the two groups of patients, respectively. There was no considerable difference in preoperative SOD and MDA between the two groups of patients ($p>0.05$). After surgery, the SOD and MDA of the two groups of patients were dramatically superior to those before surgery, showing a considerable difference ($p<0.05$). Moreover, the SOD and MDA in the TEA group were notably inferior to those in the TAPB group, and the difference was statistically substantial ($p<0.05$).

Comparison of VAS and NRS Scores of Postoperative Pain Between the Two Groups

The VAS and NRS scores of two groups of patients were recorded 1h (T1), 6h (T2), 24h (T3), and 48h (T4) after the surgery to assess the postoperative pain during rest and exercise.

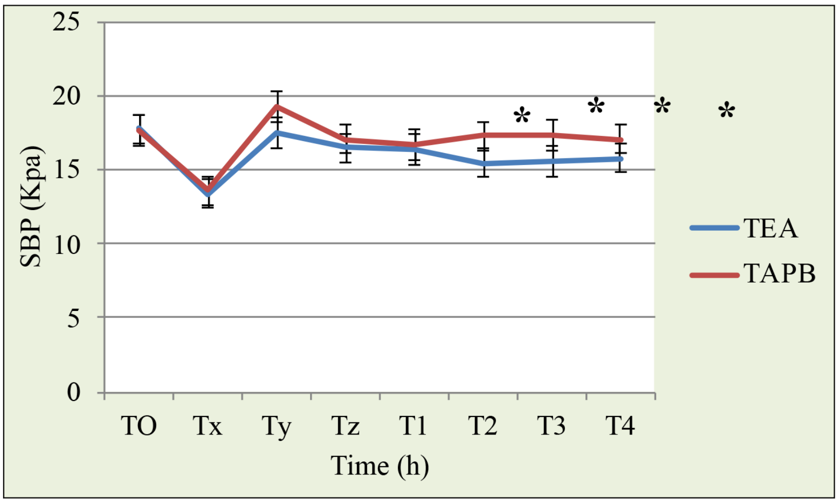

Figure 1. The changes of SBP at different time points in the two groups of patients. *indicated that there was a considerable difference in the SBP of TEA group between T1-T4 and T0 ($p<0.05$).

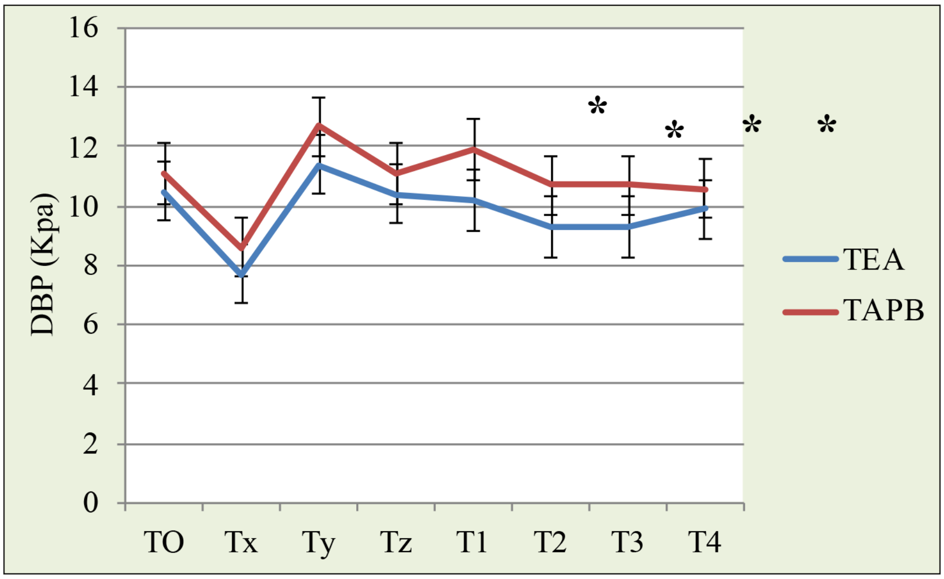

Figure 2. The changes of DBP at different time points in the two groups of patients. *indicated that there was a considerable difference in the DBP of TEA group between T1-T4 and T0 ($p<0.05$).

Comparison of VAS scores between the two groups of patients at different points after surgery at rest and during exercise

In the resting state, the VAS scores in the TEA group at all-time points after the surgery were lower than those in the TAPB group, and the difference was substantial ($p<0.01$), as illustrated in Figure 11.

In the exercise state, the VAS scores in the TEA group at all-time points after the surgery were lower than those in the TAPB group, showing statistically substantial difference ($p<0.05$), as presented in Figure 12.

Comparison of NRS scores at different time points after the surgery

The postoperative NRS scores of the two groups of patients decreased with the increase of time, and the difference was substantial ($p<0.05$). The NRS scores of patients in the TEA group at T1, T2,

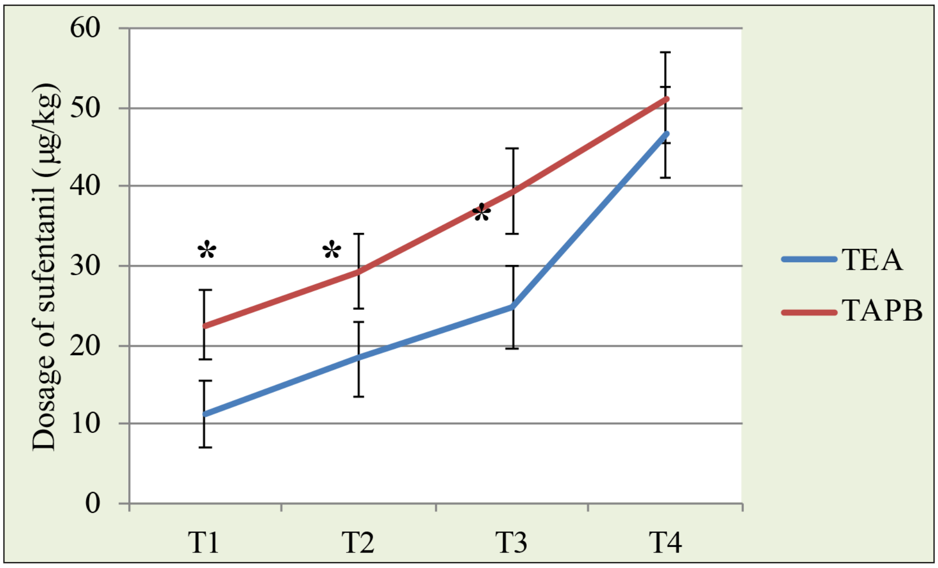

Figure 3. Sufentanil consumption in the two groups of patients at different time points after surgery. *indicated that there was a notable difference in the dosage of sufentanil between the TEA and TAPB groups at T1 and T2 ($p<0.05$).

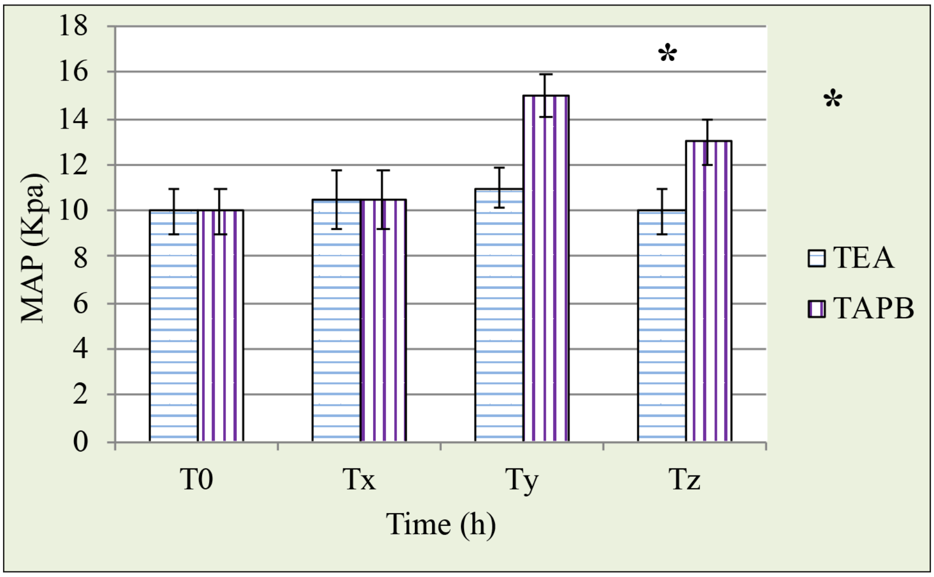

Figure 4. Changes in MAP of the two groups of patients. *indicated that there was a substantial difference in the value of MAP between the TEA and TAPB groups at Ty and Tz ($p<0.05$).

T3, and T4 were all lower than those in the TAPB group, and there was a considerable difference between the two groups ($p<0.05$) (Figure 13).

Postoperative Recovery

Table I below presented the postoperative recovery of the two groups of patients. The time of the first anus exhaust, the time of getting out of bed for the first time, and adverse reactions in the TEA group were less than those in the TAPB group, with considerable differences ($p<0.05$). In terms of satisfaction with analgesia, the TEA group was dramatically superior to the TAPB group ($p<0.05$).

NLRP3 Inflammasome Protein Before and After Surgery in the Two Groups

Table II revealed that there was no significant difference in NLRP3 inflammatory body protein level between the two groups before surgery, and

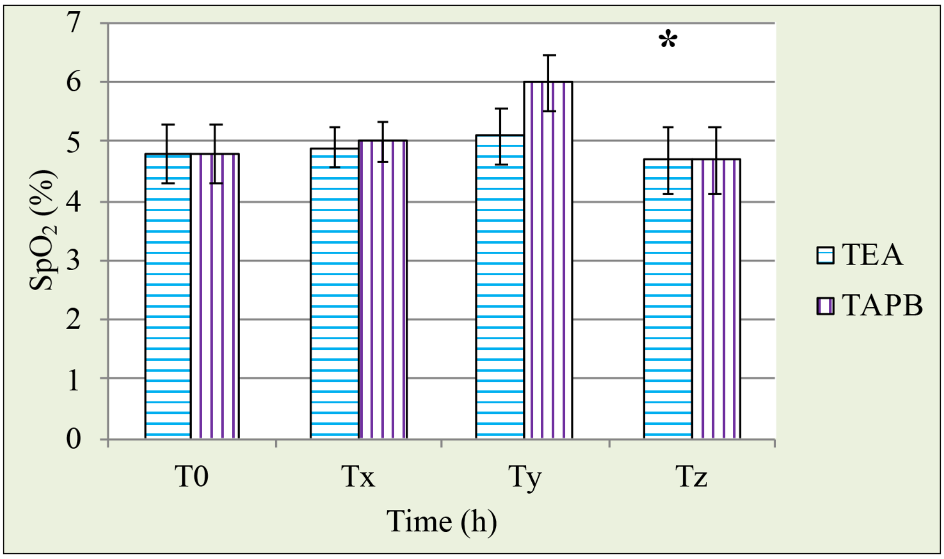

Figure 5. SpO_2 changes in the two groups of patients. *indicated that there was a great difference in SpO_2 between TEA and TAPB groups at Ty ($p<0.05$).

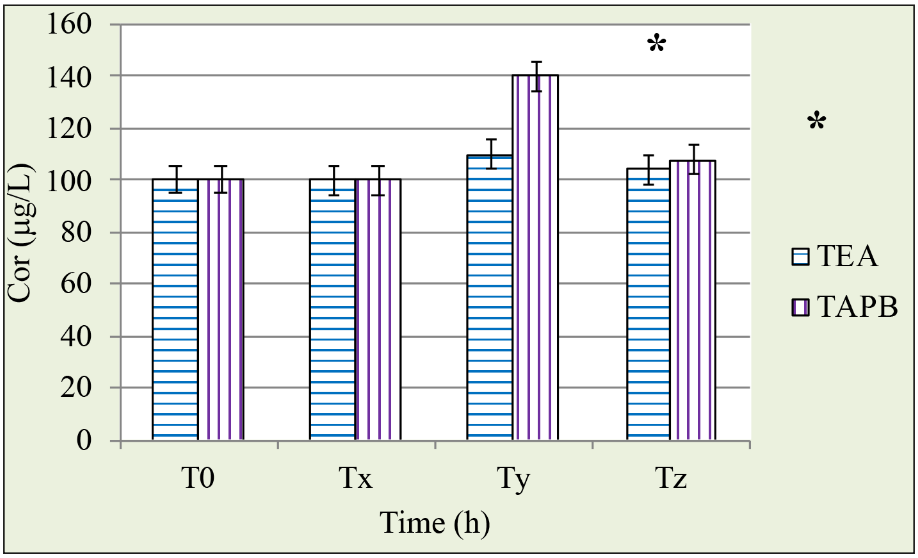

Figure 6. Changes in Cor of the two groups of patients. *indicated that there was a considerable difference in Cor between the TEA and TAPB groups at Ty and Tz ($p<0.05$).

the protein level in the TEA group was significantly lower than that in the TAPB group after surgery, with statistical significance ($p<0.05$).

Discussion

In clinical medicine, ideal anesthesia should be able to proceed smoothly on the premise of ensuring the patient's life safety, regulate the individual stress level, maintain the normal operation of organs, and reduce the side effects brought by anesthesia[12]. At present, the perioperative stress is mostly solved by improving anesthesia skills, controlling the dosage of anesthetics, and selecting effective anesthesia methods[13]. In clinical surgery, TEA or TAPB is mostly used to alleviate individual stress response before and after surgery[14].

TEA can block sympathetic nerve cells and cause peripheral blood vessels to dilate, leading to hypotension. Although there was no considerable difference in the incidence of hypotension

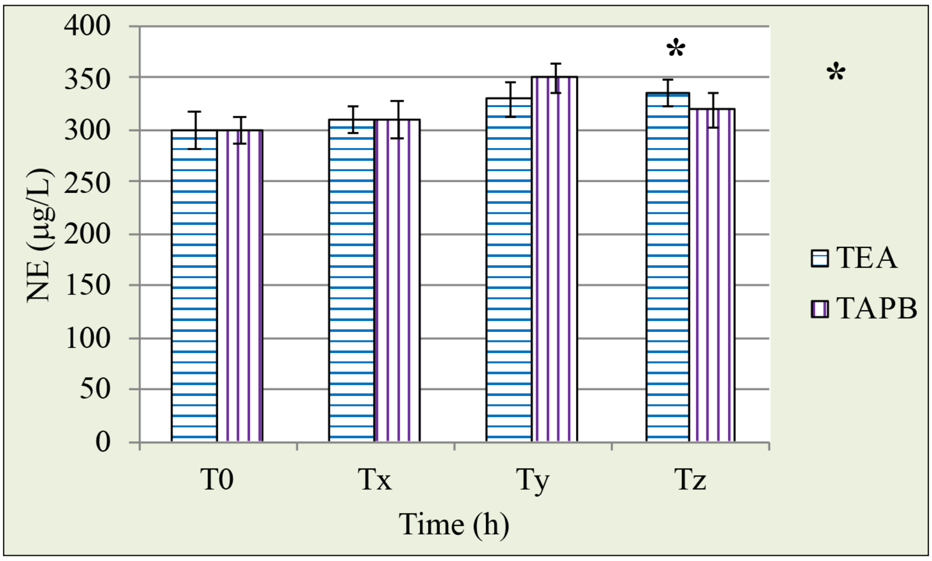

Figure 7. Changes in NE of the two groups of patients. *indicated that there was a substantial difference in the value of NE between the TEA and TAPB groups at Ty and Tz ($p<0.05$).

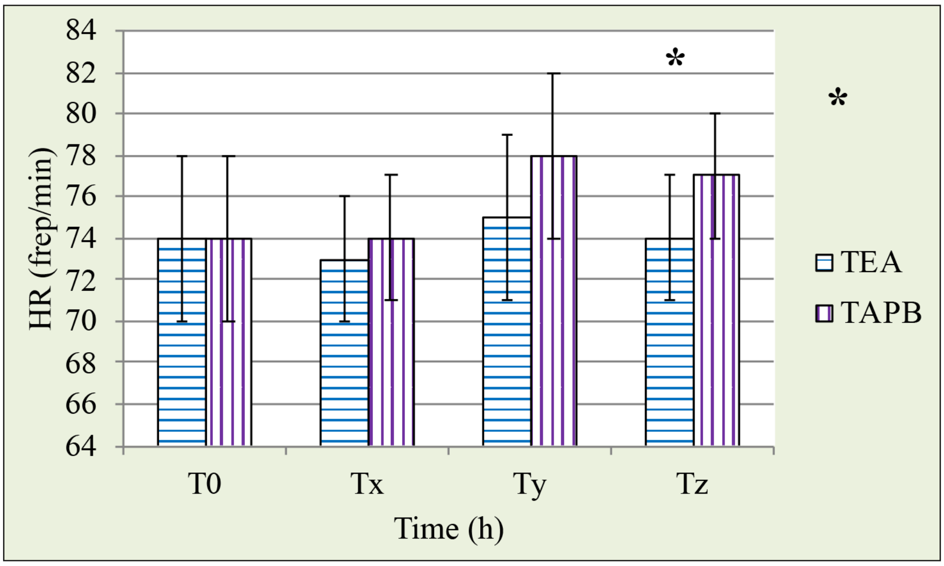

Figure 8. Changes in HR of two groups of patients. *indicated that there was a difference in HR between the TEA and TAPB groups at Ty and Tz ($p<0.05$).

between the two groups in this work, the TEA group had a lower level of blood pressure before and after surgery than the TAPB group. It was inferred that TEA was more suitable for the patients with hypotension which was difficult to bear the postoperative pain. Some studies[15-17] showed that compared with other anesthesia methods, the application of TAPB to postoperative analgesia in laparoscopic colorectal surgery can effectively shorten the time required for indwelling catheterization. This work failed to show such results, which was possibly because the puncture point was selected as a time point, and the infection to the lumbosacral plexus of the body was relatively mild. Therefore, it was necessary to strictly select the anesthesia program in clinical surgery based on the body's own weight and condition status to specify a reasonable and targeted TAPB analgesia program, which can reduce the toxicity caused by anesthesia. In addition, according to the research

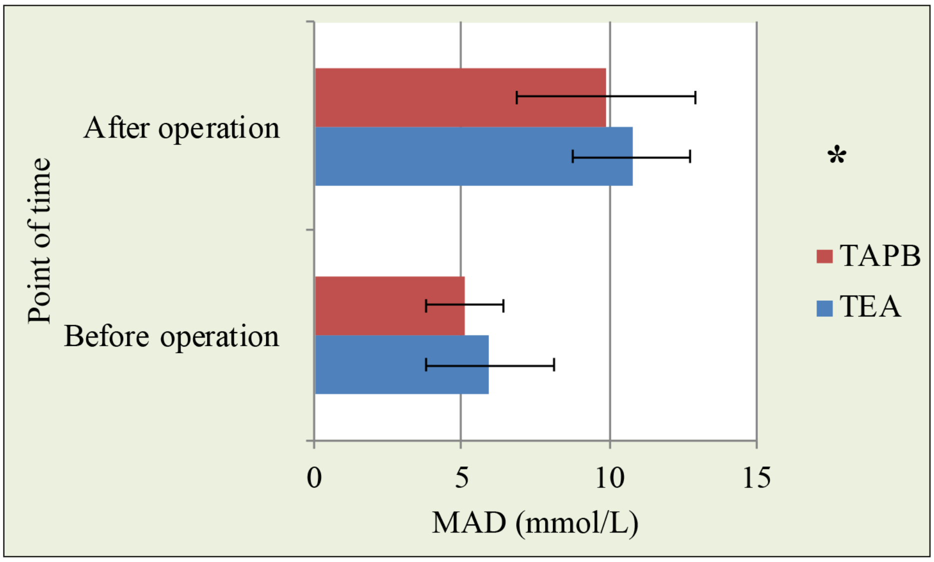

Figure 9. Shows the changes in MDA of the two groups of patients. *indicated that the MDA of TEA and TAPB groups after surgery was notably different from that before surgery ($p<0.05$).

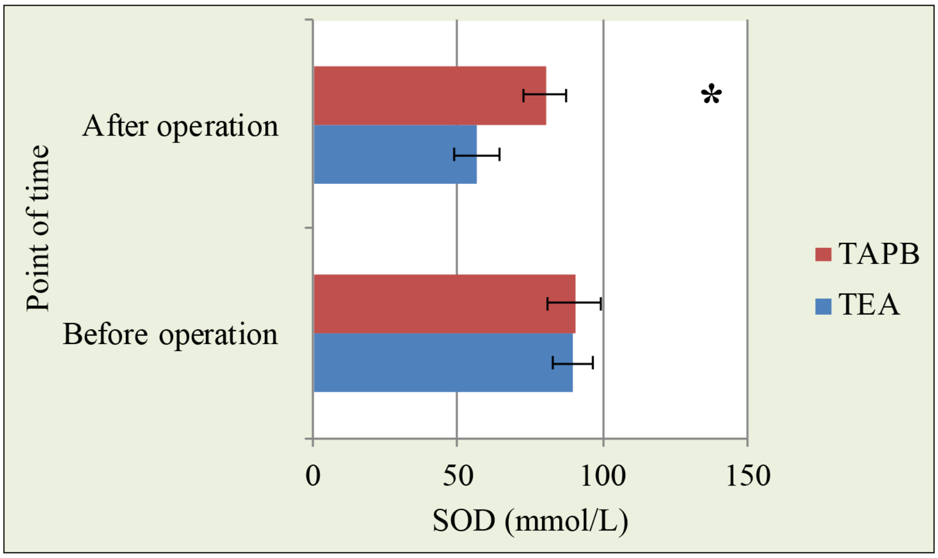

Figure 10. Changes of SOD before and after surgery in the two groups. *indicated that the SOD of TEA and TAPB groups after surgery was notably different from that before surgery (p<0.05).

results, both SBP and DBP in the TEA group decreased during T1-T4 period. There were no substantial changes in SBP and DBP indexes in the TAPB group during the period of T1-T4, indicating that the hemodynamics in the TAPB group were more stable than that in the TEA group.

The comparison of the dosage of anesthetic drugs showed that the dosage of sufentanil in the TEA group was notably inferior to that in the TAPB group at T1 and T2. In the TEA group, the incidences of dizziness and vomiting after surgery were relatively low, and patients were more satisfied with the analgesic effect. It may be that the decrease of sufentanil dosage in the TEA group resulted in a decrease in the incidence of postoperative pain, allergy, and other symptoms. In addition, there was no considerable difference in sufentanil consumption between the TEA group and the TAPB group at T3 and T4, which may be due to the weakening of the single occurrence of TEA. Future studies will be conducted to enhance the analgesic effects of continuous TEA.

Comparison of postoperative pain scores in the two groups showed that VAS scores in the TEA group were lower than those in the TAPB group at all-time points after surgery in the resting and exercise state, with considerable differences between the two groups (p<0.01). NRS scores in the TEA group were lower than those in the TAPB group at all-time points after surgery, and the difference between the two groups was substantial (p<0.05). The TEA group was superior to the TAPB group in terms of analgesia and opioid consumption, and the observation results two days after surgery showed that the analgesia duration of TEA reached 48h. Similarly, Wang et al18 also emphasized this point. These results indicated that TEA group had relatively better analgesic effect than TAPB group. This result may be due to the fact that the anesthetic in the TAPB group did not spread from the thoracolumbar fascia to the thoracic space in time. It may also be because the block of TAPB group decreased in a large area at T2 after surgery, leading to the weakening of ef-

Table I. Postoperative recovery of the two groups of patients.

Group	N	Anal exhaust time (h)	Time of getting out of bed for the first time (h)	Satisfaction with analgesia (points)	Adverse reactions (%)
TAPB group	30	31.3±1.9*	20.4±2.3*	10.4±1.1*	78*
TEA group	30	19.8±2.1	14.3±2.7	7.8±0.9	33

*indicated that there was considerable difference in postoperative recovery indicators between TEA and TAPB groups (p<0.05).

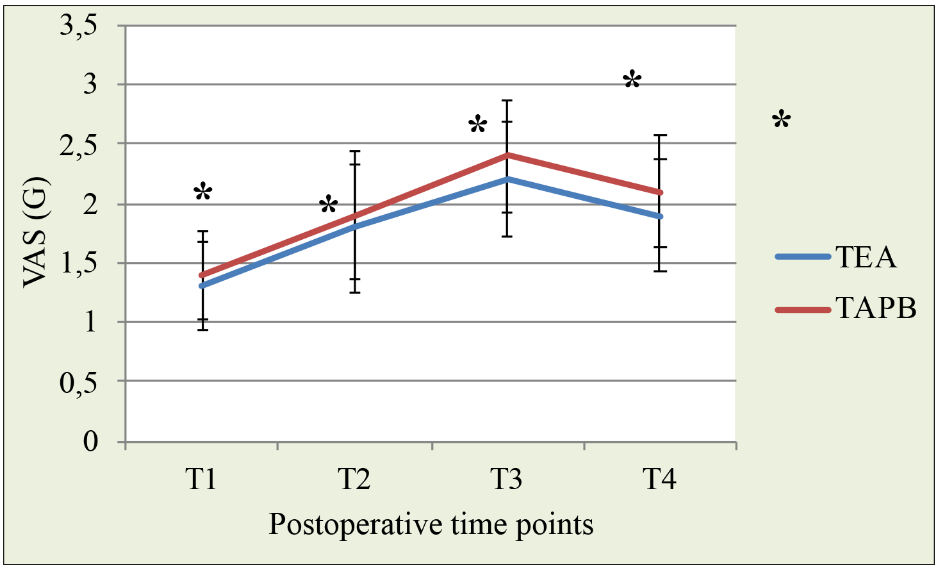

Figure 11. Comparison of resting VAS scores between the two groups of patients at various time points after surgery. *indicated that the resting VAS scores of TEA group and TAPB group were greatly different at each time point after surgery ($p<0.05$).

Table II. NLRP3 inflammasome protein before and after surgery in the two groups.

	Preoperative (β-actin)	Postoperative (β-actin)	*t*-test	*p*-value
TAPB group	0.84±0.23	0.69±0.12	26.19	0.104
TEA group	0.8±0.19	0.45±0.08*	23.47	0.036

*represents $p<0.05$, with statistical difference.

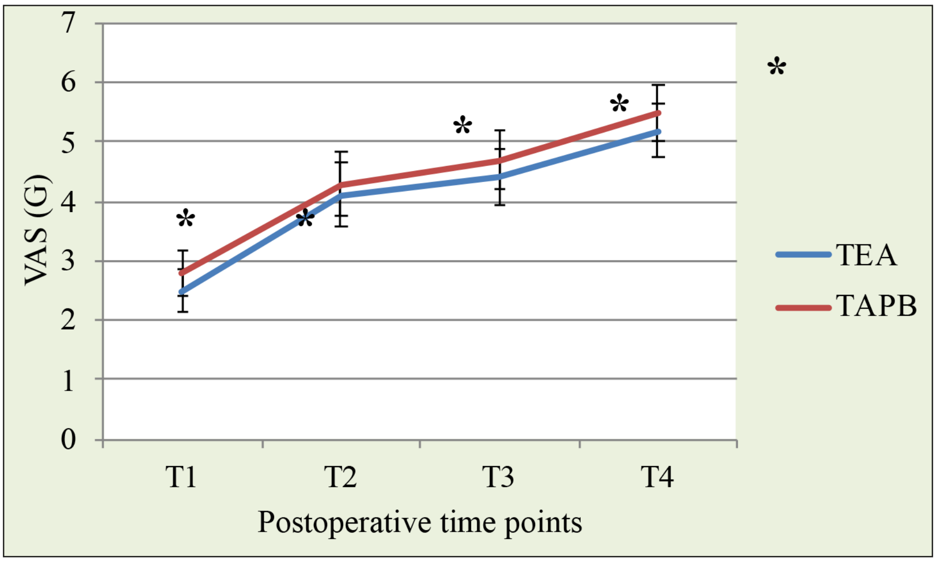

Figure 12. Comparison of sports VAS scores between the two groups of patients at various time points after surgery. *indicated that the sports VAS scores of TEA group and TAPB group were different at each time point after surgery ($p<0.05$).

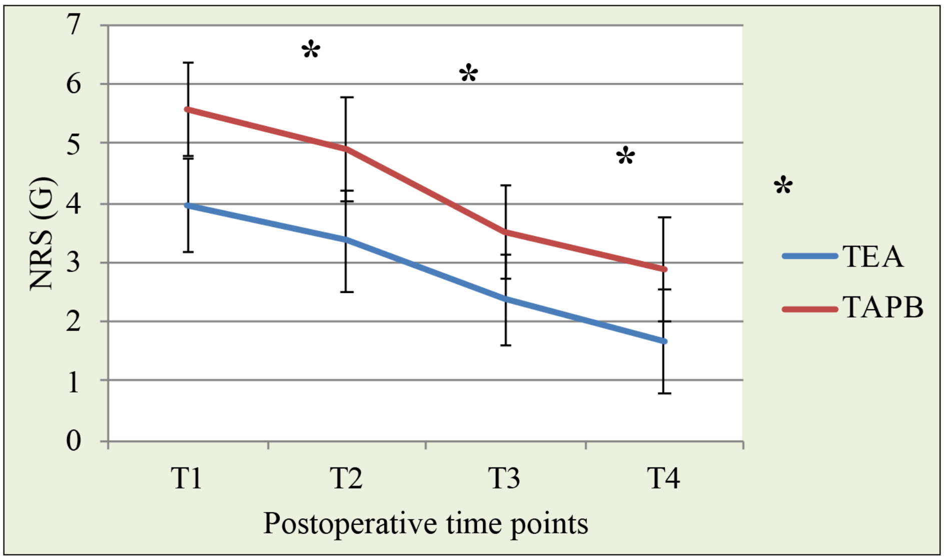

Figure 13. Comparison of NRS scores at different time points in the two groups of patients. *indicated that there was a great difference in sports NRS scores between TEA and TAPB groups at various time points after surgery (p<0.05).

fect of anesthetics and reduction of the area. Surgeons quickly injected TAPB after surgery, which resulted in the drug acting on a small scale and making the effects difficult to sustain. Faced at this situation, rapid injection should be changed into a single injection to expand the scope of anesthetic agents, overcome the previous deficiencies, expand the block plane, and enhance the anesthesia time and analgesic effect[19,20].

During and after the laparoscopic surgery, minimally invasive and traction causes individuals to easily suffer gastrointestinal diseases after surgery, leading to various complications. By causing gastrointestinal discomfort and affecting eating, the recovery time was long. Current study on postoperative recovery of patients in the two groups showed that compared with the TAPB group, patients in the TEA group had better postoperative intestinal function recovery effect, and the satisfaction of analgesia in the TEA group was dramatically superior to that in the TAPB group. Moreover, since patients in the TEB group were able to get out of bed earlier, their physical indicators recovered more quickly, which improved their body functions, shortened the recovery time, and reduced the discomfort and side effects of anesthetic drugs. These results suggested that TEA mediated activation of inflammasome had a better effect on postoperative laparoscopic analgesia than TAPB.

In this work, patients undergoing laparoscopic colorectal surgery were divided into a TAPB group (30 patients) and a TEA group (30 patients) according to different anesthesia method adopted. SBP, DBP, HR, MAP, SpO_2, Cor, NE, SOD, and MDA of patients were observed and compared at different time points before and after anesthesia. Postoperative anesthesia dose was recorded, and postoperative pain VAS and NRS scores were assessed. Moreover, the first anal exhaust, the time of getting out of bed, the satisfaction of analgesia, adverse reactions, and other postoperative recovery were compared between the two groups. The results showed that the dose of sufentanil in TEA group (19.71±5.11 g/kg) was notably inferior to that in TAPB group (30.28±4.31 g/kg) (p<0.05). SBP and DBP in TEA group during T1 to T4 period decreased remarkably (p<0.05), and the changes of blood pressure in TAPB group were stable. The stress indexes of HR, MAP, Cor, and NE in TEA group were lower than those in TAPB group during the period from pneumoperitoneum establishment to aeration release, and SpO_2 was lower than that in TAPB group at the same time point after pneumoperitoneum establishment (p<0.05). In addition, the VAS and BRS scores in TEA group were lower than those in TAPB group at each time point (p<0.05). The first time of anal exhaust and the first time of getting out of bed in TEA group were less than those in TAPB group (p<0.05).

Conclusions

The aggregation and activation of NLRP3 inflammasome can be improved through epidural block mediating, and the dosage of anesthetic drugs after laparoscopic colorectal surgery can be reduced, thus helping to maintain intraoperative hemodynamic stability and reduce surgical stress response. In addition, TEA had little effect on early immunity, which was safe and feasible, contributing to the postoperative analgesia and recovery. Its application value in laparoscopic postoperative analgesia is superior to TAPB. The weakness of this work lies in that due to the small sample size, the research results will have certain errors and bias relative to the overall population, so it is difficult to popularize. Therefore, it is necessary to expand the sample size and further discuss and study the large sample in the future research to overcome the deficiencies and promote the generalization of the conclusions.

Conflict of Interest

The Authors declare that they have no conflict of interests.

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Ethics Approval

This study was approved by the Institutional Review Board of Fudan University, Shanghai, China. All procedures performed in studies involving human participants with the 1964 Helsinki Declaration (No. 20ZR14122600).

Informed Consent

Informed consent was obtained from all study participants.

Availability of Data and Materials

All data generated or analyzed during this study are included in this published article.

Authors' Contributions

YL, ZS, LL, XZ, LG, JW, LY, and PX conceived and designed the experiments, data collection, analyzed the data, and wrote the manuscript. All authors read and approved the final manuscript.

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