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Total intravenous anesthesia on the quality of early recovery in patients with pulmonary tuberculosis undergoing argon plasma coagulation

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Abstract: Objective To compare the effects of total intravenous anesthesia (TIVA) and inhalation anesthesia on early postoperative recovery quality, adverse events and postoperative deliriurn in patients with pulmonary tuberculosis undergoing argon plasma coagulation (APC). **Methods** A total of 90 pulmonary tuberculosis patients who underwent APC at Second Hospital of Nanjing from September 1st , 2022, to September 30th, 2024, were prospectively selected. The patients were randomly divided into Group T and Group I, with 45 patients in each group. In the Group T, propofol-based TIVA and routine medications were used for anesthesia induction, while in the Group I, sevoflurane- based inhalation anesthesia and routine medications were used. The following parameters were recorded: general data, surgery duration, anesthesia duration, extubation time, time to leave the operating room, fluid replacement volume, (vital signs, intraoperative adverse events, and cough intensity during extubation. Postoperative recovery was assessed over the first 7 days, including pain [using the Visual Analog Scale (VAS)], nausea and vomiting, dizziness, recovery quality [using the 15-item Quality of Recovery (QoR-15) scale], and the occurrence of delirium [using the Confusion Assessment Method for the Intensive Care Unit, (CAM- ICU)]. **Results** There was a significant time effect on mean arterial pressure (MAP) , heart rate, and saturation of peripheral oxygen (SpO_2) in both groups (P<0.05) , but no significant group effect or interaction effect was observed (P>0.05). Pairwise comparisons showed that MAP decreased after induction in both groups (P<0.05). Heart rate was lower in Group T than in Group I when leaving the operating room, Heart rate decreased intraoperatively in both groups (P<0.05) , but Heart rate in Group I before anesthesia exceeded that when leaving the operating room ((P<0.05) ; SpO2 increased after induction but was lower before anesthesia than that when leaving the operating room (P<0.05). There was no significant differences in the incidence of hypotension, hypertension, hypoxemia, or bradycardia between the two groups (P>0.05) , but the incidence rates of tachycardia was lower in Group T than that in Group I (15.56% *vs* 62.22% , $\chi 2$ =20.618, P<0.01). There was no significant difference in cough intensity at extubation between the two groups (Z=1.567, P=0.117). There was no significant difference in VAS and QoR-15 scores between the two groups (P>0.05). Compared with preoperative day 1, (both groups had decreased QoR-15 scores on postoperative day 1 and day 2 (P<0.05). There was no significant difference in the incidence of delirium on postoperative day 1 between Groups I and (11.11% *vs* 8.89%, $\chi 2$ =0.123, P=0.725). The incidence of dizziness in Group T was significantly lower than that in Group I at 4 hours postoperatively (P<0.05). Similarly, the incidences of nausea and vomiting were significantly lower in Group T compared to Group I at 2, 4, and 6 hours postoperatively (P<0.05). **Conclusion** In pulmonary tuberculosis patients undergoing APC, total intravenous anesthesia showed more stable blood pressure and heart rate control compared to inhalation anesthesia, as well as a lower incidence of nausea, vomiting, and dizziness.

Keywords: Inhalation anesthesia; Total intravenous anesthesia; Argon plasma coagulation; Pulmonary tuberculosis; (Mean arterial pressure; Postoperative delirium; Oxygen saturation

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Tuberculosis, as a severe infectious disease, is a major public health concern globally. According to the *Global Tuberculosis Report 2024* released by the World Health Organization, the estimated global incidence of tuberculosis in 2023 reached 10.8 million cases; despite significant advances in anti-tuberculosis drug therapy, it still causes 1.25 million deaths worldwide each year [1]. For patients with drug-resistant tuberculosis or complicated with airway obstruction, traditional pharmacotherapy can hardly meet clinical needs. Argon plasma coagulation (APC), a minimally invasive treatment modality, has demonstrated favorable efficacy in airway stenosis, scar repair, and tuberculous lesion clearance [2]. Such procedures require general anesthesia, and the choice of anesthesia strategy significantly influences the postoperative recovery process of patients.

Anesthetic agents act on the respiratory, circulatory, digestive, nervous, immune and other systems, exerting significant potential impacts on surgical outcomes and patient rehabilitation [3-7]. Inhalation anesthesia (IA) and total intravenous anesthesia (TIVA) are two commonly used clinical anesthesia approaches, with distinct differences in their effects on patients' intraoperative physiological status, postoperative recovery, and complication rates [3-4]. However, systematic clinical studies on the specific impacts of these two anesthesia

methods on the recovery of tuberculosis patients after APC surgery remain lacking. This study aims to compare the effects of IA and TIVA on the early recovery of tuberculosis patients following APC surgery.

1 Materials and Methods

1.1General Information

This study was a single-center randomized controlled trial approved by the Ethics Committee of Second Hospital of Nanjing (approval number: 2022-LS-ky024), and the research protocol complied with the Declaration of Helsinki. All methods were performed in accordance with relevant guidelines and regulations, and written informed consent was obtained from all subjects. Tuberculosis patients who underwent APC at Second Hospital of Nanjing from September 1, 2022 to September 30, 2024 were recruited.

(1) Inclusion criteria: ① Aged 18-65 years; ② American Society of Anesthesiologists (ASA) physical status classification I-III; ③ Body mass index (BMI) of 18-28 kg/m²; ④ Patients and their families were informed of and consented to the study content.

(2) Exclusion criteria: ① Final diagnosis was non-tuberculosis; ② Complicated with underlying diseases such as hypertension or diabetes; ③ Allergic to study drugs; ④ Language, mental or cognitive impairment; ⑤ History of drug dependence or alcohol abuse; ⑥ Preoperative major organ dysfunction.

Patients were divided into the TIVA group (Group T) and IA group (Group I) using the random number table method. Both patients and follow-up personnel were unaware of the anesthesia method used.

1.2 Anesthesia Methods

All patients fasted for 8 hours and abstained from fluids for 4 hours preoperatively. Upon admission to the operating room, routine monitoring of vital signs and bispectral index (BIS) was performed, peripheral venous access was established, and sodium acetate Ringer's injection (Hubei Duorui Pharmaceutical Co., Ltd., batch number: B22041104) was infused. Mask oxygenation was initiated during induction for both groups, and all patients received midazolam (Jiangsu Nhwa Pharmaceutical Co., Ltd., batch number: MD220406) 0.04 mg/kg, sufentanil (Yichang Humanwell Pharmaceutical Co., Ltd., batch number: 21A11171) 0.5 μg/kg, and rocuronium bromide (Zhejiang Xianju Pharmaceutical Co., Ltd., batch number: 210305) 0.6 mg/kg. Group T received propofol (Xi'an Libang Pharmaceutical Co., Ltd., batch number: 22205121) 1.5-2.5 mg/kg; Group I inhaled 2%-6% sevoflurane (Jiangsu Hengrui Medicine Co., Ltd., batch number: 22011031) until BIS ≤60, then endotracheal intubation was performed using a size 8.0 tube. Ventilation parameters were set as follows: tidal volume 7 mL/kg, respiratory rate 12 breaths/min, inspiratory-expiratory ratio 1:2, oxygen flow rate 1 L/min, and air flow rate 3 L/min. At the start of surgery, 5 mL of 2% lidocaine (Shandong Hualu Pharmaceutical Co., Ltd., batch number: D22D17-1) was injected via a flexible bronchoscope for local infiltration of the glottis and trachea. To maintain stable intraoperative BIS values, group T received propofol at 4-6 $mg \cdot kg^{-1} \cdot h^{-1}$ and remifentanil (Sinopharm Group Co., Ltd. Langfang Branch, batch number: 20220701) at 0.01 $mg \cdot kg^{-1} \cdot h^{-1}$; group I received sevoflurane at 1.7%-4% and remifentanil at 0.01 $mg \cdot kg^{-1} \cdot h^{-1}$. Drug administration was stopped at the end of surgery, and patients waited for awakening in the operating room.

1.3 Observation Indicators

1.3.1 General Information

Including gender, age, BMI, ASA classification, and whether complicated with anemia or liver function abnormalities.

1.3.2 General Indicators of Anesthesia and Surgery

Operation time, anesthesia time, extubation time, time to leave the operating room, fluid infusion volume, vital signs, adverse events in the operating room, and cough severity at extubation were recorded. Extubation time was defined as the duration from the end of surgery to extubation. Time to leave the operating room was defined as the duration from the end of surgery to leaving the operating room. Hypotension was defined as mean arterial pressure (MAP) <60 mmHg or a decrease in systolic blood pressure ≥20% from the baseline value. Respiratory depression was defined as saturation of peripheral oxygen (SpO_2) <90%. Cough severity at extubation was classified into 3 grades according to the method of Minogue *et al.* [8], mild (single cough), moderate (more than one cough lasting ≤5 seconds), and severe (cough lasting ≥5 seconds).

1.3.3 Postoperative Pain, Nausea, Vomiting and Dizziness

Visual Analogue Scale (VAS) scores were assessed at 2, 4, 6 hours postoperatively, and on the 1st, 2nd, 3rd, 5th, and 7th days postoperatively. The occurrence of nausea and vomiting, and dizziness was also recorded. In the VAS score, 0 indicated no pain and 10 indicated the most severe unbearable pain.

1.3.4 Recovery Status, Sleep Status and Cognitive Function

The 15-item Quality of Recovery (QoR-15) scale [9], Insomnia Severity Index (ISI) [10], and Mini-Mental State Examination (MMSE) [11] were used to evaluate recovery quality, sleep quality, and cognitive function respectively at 6 time points: 1 day before surgery, and on the 1st, 2nd, 3rd, 5th, and7th days postoperatively. In terms of evaluating postoperative recovery quality, the QoR-15 has a maximum score of 150, where higher scores indicate better postoperative recovery quality for patients. The ISI consists of 7 questions with a maximum

score of 28; an increase in score reflects a decline in the patient's sleep quality. The MMSE has a maximum score of 30, and higher scores indicate better cognitive function in patients.

1.3.5 Postoperative Delirium

Postoperative delirium was followed up and assessed using the Confusion Assessment Method for the Intensive Care Unit (CAM-ICU) [12] at 5 time points: on the 1st,2nd,3rd,5th, and7th days postoperatively.

1.4 Statistical Methods

The trend test of the preliminary pilot study was calculated using PASS 15 software. The incidence of postoperative nausea and vomiting was 30% in Group T and 60% in Group I. Setting two-tailed α=0.05 and 1-β=0.8, the calculated sample size was 82 patients (41 cases per group). Considering an expected 10% drop-out rate, 45 cases were initially allocated to each group. Statistical analysis was performed using SPSS 25.0 software. Continuous variables with normal distribution were expressed as $\bar{x} \pm s$, and inter-group comparisons were conducted using independent sample *t* test. For comparisons across multiple time points, repeated-measures analysis of variance (ANOVA) was used, followed by LSD-*t* test for pairwise comparisons. Continuous variables with non-normal distribution were presented as median (first quartile, third quartile) [*M* (Q_1,Q_3)], and inter-group comparisons were done using Mann-Whitney U test. Categorical variables were expressed as *n*(%), and comparisons were made using chi-square test or Fisher's exact test. Generalized estimating equations were applied for comparisons of non-normal and categorical variables across multiple time points. For simple effect analysis of different time points within the same group, Friedman test and Wilcoxon signed-rank test were used; Mann-Whitney U test was used for comparisons between groups at the same time point. A *P* value <0.05 was considered statistically significant.

2 Results

2.1 Comparison of General Information Between the Two Groups

A total of 139 patients undergoing APC surgery were screened in this study. Subsequently, 34 patients were excluded based on inclusion and exclusion criteria. Additionally, 15 patients who were later diagnosed with non-pulmonary tuberculosis or lost to follow-up were eliminated. Finally, 90 subjects were included in the analysis, with 45 cases in each group. There were no statistically significant differences between the two groups in gender, age, BMI, ASA classification, comorbidities, operation time, anesthesia time, extubation time, time to leave the operating room, or fluid infusion volume (all P>0.05). See **Tables 1** and **2**.

2.2 Comparison of Perioperative Vital Signs Between the Two Groups

There were significant time effects for MAP, heart rate (HR), and SpO_2 in both groups (*P*<0.01), while no statistically significant inter-group effects or interaction effects were found (*P*>0.05). See **Table 3**. Pairwise comparisons showed that compared with the pre-anesthesia baseline, MAP in Group T was significantly decreased at post-induction (*P*<0.01), the start of surgery (*P*<0.01), the end of surgery (*P*<0.01), and the time of leaving the operating room (*P*=0.012). In Group I, MAP decreased at post-induction, the start of surgery, and the end of surgery, but the differences were not statistically significant (*P*>0.05).

Regarding HR, inter-group comparison revealed that HR in Group T was lower than that in Group I at the time of leaving the operating room (*t*=2.413, *P*=0.018). Time-point analysis showed that HR in Group T at the end of surgery was lower than the pre-anesthesia level (*P*=0.022). In Group I, HR was lower than the pre-anesthesia level at post-induction (*P*=0.020), the start of surgery (*P*=0.031), and the end of surgery (*P*=0.004), but significantly higher than the baseline at the time of leaving the operating room (*P*=0.009).

Analysis of SpO_2 indicated that SpO_2 in Group T increased at post-induction (*Z*=1.333, *P*<0.01) but was lower than the pre-anesthesia level at the time of leaving the operating room (*Z*=1.578, *P*<0.01). In Group I, SpO_2 increased at post-induction (*Z*=1.456, *P*<0.01) and the start of surgery (*Z*=0.967, *P*<0.01), and decreased at the time of leaving the operating room (*Z*=1.356, *P*<0.01).

2.3 Comparison of Adverse Events Between the Two Groups

There were no statistically significant differences in the incidence rates of hypotension, hypertension, hypoxemia, or bradycardia between the two groups (*P*>0.05). The incidence rate of tachycardia in Group T was significantly lower than that in Group I (*P*<0.01). See **Table 4**.

Tab.1 Comparison of the general data between two groups (*n*=45)

Group	Male/female	Age [years, *M* (Q_1,Q_3)]	BMI (kg/m², ±s)	ASA classification II/III (cases)	Anemia [cases(%)]	Abnormal liver function [cases(%)]
Group T	18/27	42(32, 56)	21.99±2.48	44/1	1(2.22)	4(8.89)
Group I	16/29	43(29, 56)	21.63±2.48	43/2	1(2.22)	5(11.11)
χ^2/*Z*/*t* value	0.189	0.057	0.676			
***P* value**	0.664	0.955	0.501	1.000	1.000	1.000

Tab.2 Comparison of general indicators of surgical anesthesia between two groups [n=45, $M(Q_1,Q_3)$]

Group	Operation time (min)	Anesthesia time (min)	Extubation time (min)	Time to leave the operating room (min)	Fluid infusion volume (mL)
Group T	30.0(21.0, 40.0)	40.0 (30.5, 52.5)	20.0 (15.0, 26.0)	40.0 (35.0, 47.5)	400.0 (350.0, 450.0)
Group I	27.0(16.0, 39.5)	35.0 (29.0, 45.0)	20.0 (15.0, 25.0)	40.0 (32.5, 45.0)	400.0 (350.0, 450.0)
***Z* value**	1.339	1.395	1.102	0.949	1.169
***P* value**	0.181	0.163	0.271	0.343	0.242

Tab.3 Comparison of vital signs between two groups (n=45)

Time point	MAP(mmHg, $\bar{x}\pm s$)		HR(times/min, $\bar{x}\pm s$)		SpO_2[%, $M(Q_1,Q_3)$]	
	Group T	Group I	Group T	Group I	Group T	Group I
Pre-anesthesia	89.24±10.23	87.82±11.53	81.58±11.77	83.29±13.97	98 (97, 99)	98 (96, 98)
Post-induction	79.84±8.91[a]	81.38±9.65[a]	76.73±10.83	76.67±15.77[a]	100 (99, 100)[a]	100 (99, 100)[a]
At start of surgery	78.73±11.65[a]	81.49±11.46[a]	83.29±5.95	81.58±6.91[a]	99 (98, 100)	99 (98, 100)[a]
At end of surgery	71.96±7.61[a]	75.18±9.06[a]	74.02±11.20[a]	75.93±15.04[a]	98 (96, 99)	97 (96, 98)
At leaving operating room	85.02±10.54[a]	85.93±12.26	82.80±14.18[a]	89.64±12.68[ab]	94 (94, 96)[b]	95 (93, 96)[a]
***F*/χ^2 group/time/interaction value**	0.949/41.446/0.915		1.759/15.036/1.151		2.815/328.930/5.779	
***P* group/time/interaction value**	0.333/<0.001/0.459		0.188/<0.001/0.332		0.093/<0.001/0.216	

Note: [a] P<0.05 compared with pre-anesthesia in the same group; [b] P<0.05 compared with Group T.

2.4 Comparison of Cough Severity at Extubation Between the Two Groups

In Group T, there were 7 cases of mild cough, 13 cases of moderate cough, and 2 cases of severe cough. In Group I, there were 6 cases of mild cough, 17 cases of moderate cough, and 8 cases of severe cough. There was no statistically significant difference in cough severity at extubation between the two groups (Z=1.567, P=0.117).

2.5 Comparison of VAS Scores at Different Time Points

For resting postoperative VAS scores, there was a significant main effect of time (P<0.01), but no significant main effect of group (P=0.784) or time×group interaction effect (P=0.236). For VAS scores during activity, both the main effect of time (P<0.01) and time×group interaction effect (P=0.009) were significant, while the main effect of group was not statistically significant (P=0.617). Pairwise comparisons showed no statistically significant differences in activity VAS scores between the two groups at any time point (all P>0.05). See **Table 5**.

2.6 Comparison of QoR-15 Scores at Different Time Points

A significant main effect of time was found for QoR-15 scores (P<0.01), with significant improvement postoperatively compared to preoperatively. However, no significant main effect of group or time×group interaction effect was observed (all P>0.05). Compared with 1 day before surgery, QoR-15 scores in both groups were significantly decreased on the 1st day postoperatively (Group T: Z=2.933, P<0.01; Group I: Z=2.756, P<0.01) and the 2nd day postoperatively (Group T: Z=1.667, P<0.01; Group I: Z=1.544, P<0.01). See **Table 6**.

Tab.4 Comparison of adverse events between two groups [n=45, case(%)]

Group	Hypotension	Hypertension	Respiratory Depression	Bradycardia	Tachycardia
Group T	25(55.56)	4(8.89)	7(15.56)	2(4.44)	7(15.56)
Group I	33(73.33)	10(22.22)	5(11.11)	2(4.44)	28(62.22)
χ^2 value	7.395	3.045	0.385		20.618
***P* value**	0.007	0.081	0.535	1.000[a]	<0.001

Note: [a] Fisher's exact test.

Tab.5 Comparison of postoperative VAS score between two groups [n=45, $M(Q_1,Q_3)$]

Time point	Resting VAS score		Activity VAS score	
	Group T	Group I	Group T	Group I
2 h Postoperative	1.0(0.5,3.0)	2.0 (1.0,3.0)	3.0 (2.0,4.0)	3.0 (2.0,5.0)
4 h Postoperative	2.0 (1.0,3.0)	2.0 (1.0,3.0)	3.0 (2.0,4.0)	3.0 (2.0,5.0)
6 h Postoperative	1.0 (0.5,2.5)	2.0 (0.5,3.0)	3.0 (2.0,3.5)	3.0 (2.0,5.0)
1st postoperative day	0(0,1.0)	0(0,1.0)	1.0 (1.0,2.0)	1.0 (0,2.5)
2nd postoperative day	0(0,0.5)	0(0,0)	1.0 (0,1.0)	0(0,1.0)
3rd postoperative day	0(0,0)	0(0,0)	0(0,1.0)	0(0,0)
5th postoperative day	0(0,0)	0(0,0)	0(0,0)	0(0,0)
7th postoperative day	0(0,0)	0(0,0)	0(0,0)	0(0,0)
χ^2/*P* group value	171.056/<0.001		307.550/<0.001	
χ^2/*P* time value	0.075/0.784		0.251/0.617	
χ^2/*P* interaction value	8.034/0.236		17.078/0.009	

2.7 Comparison of Postoperative Delirium Incidence at Different Time Points

The highest incidence of postoperative delirium was observed on the 1st day postoperatively in both groups (3 cases in Group T *vs* 4 cases in Group I). On the 2nd day postoperatively, 1 case of postoperative delirium was reported in each group. No statistically significant difference in the incidence of postoperative delirium was found between the two groups (11.11% *vs* 8.89%, χ^2=0.123, P=0.725).

2.8 Comparison of Dizziness, Nausea and Vomiting at Different Time Points

The severity of dizziness symptoms changed over time in both groups (P<0.01), with significant inter-group differences (P<0.01) and a significant time×group interaction effect (P<0.01). Simple effect analysis showed that the incidence of dizziness in Group T was lower than that in Group I at 4 hours postoperatively (χ^2=4.121, P=0.042). For the incidence of postoperative nausea and vomiting, significant time effects, inter-group effects, and time×group interaction effects were observed (P<0.01). Compared with Group I, the incidence of nausea and vomiting in Group T was lower at 2 hours (χ^2=8.715, P=0.003), 4 hours (χ^2=7.511, P=0.006), and 6 hours postoperatively (χ^2=5.475, P=0.019). However, the difference gradually diminished over time, and no statistically significant difference was found on the 1st day postoperatively (χ^2=1.011, P=0.315). No dizziness, nausea, or vomiting were observed on the 3rd, 5th, or 7th days postoperatively. See **Table 7**.

Tab.6 Comparison of QoR-15 scores between two groups at different time points [n=45，$M(Q_1,Q_3)$]

Group	1 day preoperative	1st postoperative day	2nd postoperative day	3rd postoperative day	5th postoperative day	7th postoperative day
Group T	142(140, 144)	134(130, 140)[a]	139(135, 142)[a]	140(139, 143)	141(140, 145)	143(140, 145)
Group I	142(138, 144)	135(132, 140)[a]	140(135, 143)[a]	142(138, 144)	143(140, 145)	144(142, 145)
χ^2/P_{group} value	315.292/<0.001					
χ^2/P_{time} value	0.238/0.625					
$\chi^2/P_{interaction}$ value	6.577/0.254					

Note: Compared with the same group at 1 day before surgery, [a] P<0.05.

Tab.7 Comparison of dizziness, nausea and vomiting after operation between two groups [n=45, case (%)]

Group	Dizziness					Nausea and vomiting				
	2 h	4 h	6 h	1st day	2nd day	2 h	4 h	6 h	1st day	2nd day
Group T	30(66.67)	26(57.78)[a]	26(57.78)	4(8.89)	0	16(35.56)[a]	16(35.56)[a]	14(31.11)[a]	0	0
Group I	36(80.00)	35(77.78)	34(75.56)	6(13.33)	1(2.22)	30(66.67)	29(64.44)	25(55.56)	1(2.22)	0
χ^2/P_{group} value	1 081.214/<0.001					17 395.595（85.483）/<0.001				
χ^2/P_{time} value	152.869/<0.001					225.634（11.778）/<0.001				
$\chi^2/P_{interaction}$ value	595.552/<0.001					569.887（114.828）/<0.001				

3 Discussion

As medical science advances continuously, the treatment strategies for pulmonary tuberculosis have become increasingly diverse. Choosing an appropriate anesthesia regimen to facilitate postoperative recovery in pulmonary tuberculosis patients is a critical topic worthy of in-depth exploration. This study found that pulmonary tuberculosis patients who received TIVA during APC surgery exhibited lower incidences of complications and adverse events.

Propofol has a circulatory inhibitory effect; which directly suppresses myocardial contraction and acts on vascular smooth muscle to dilate peripheral blood vessels, leading to hypotension. Inhalational anesthetics also weaken myocardial contractility and lower blood pressure [13-14]. The results of this study showed that by adjusting the BIS value to maintain anesthesia depth, there was no significant difference in MAP between the two groups, while blood pressure decreased in both groups after induction. Studies have proven that rapid inhalation of sevoflurane does not cause a significant increase in heart rate and can maintain stable cardiac output, with relatively minor effects on heart rate and blood pressure [15]. Propofol can inhibit and reset the baroreflex, weakening the body's tachycardic response to hypotension, which also results in non-obvious changes in patients' heart rate [16-17]. Pulmonary tuberculosis is a chronic consumptive disease often accompanied by respiratory function impairment. At the time of postoperative discharge from the operating room, the SpO_2 of patients in both groups was lower than that before surgery, which may be due to airway stimulation from endotracheal manipulation during APC surgery affecting respiratory function. Propofol can effectively treat postoperative nausea and is used for refractory nausea and vomiting, with effects lasting several hours; the situation of patients in the intravenous anesthesia group in this study was consistent with previous findings [18]. Sevoflurane can dilate cerebral blood vessels and increase cerebral blood flow and intracranial pressure, while propofol reduces cerebral blood flow, intracranial pressure, and cerebral oxygen consumption—these properties may be related to the difference in patients' dizziness perception [19]. Consistent with the results of Niu *et al.* [3], the heart rate of patients receiving intravenous anesthesia was lower than that of the inhalation anesthesia group at discharge, which may be related to fewer nausea, vomiting, and dizziness symptoms. Both sevoflurane and propofol are short-acting drugs with rapid metabolism and elimination, which not only ensures patient safety but also results in small differences in postoperative pain scores.

The QoR-15 scale, as a tool for evaluating postoperative recovery quality, has shown good reliability, validity, and clinical applicability [20]. Similar to the study results of Lee *et al.* [21], there was no significant difference in QoR-15 scores between the T group and I group in this study. Given that APC surgery has less trauma than traditional surgery, patients have weaker pain perception, and this procedure helps restore airway patency, the QoR-15 scores of patients in both groups

returned to baseline levels on the 3rd postoperative day; in contrast, patients cannot fully recover until 5-7 days after more traumatic surgical procedures [22]. Postoperative delirium is a common and serious complication in elderly patients, which seriously affects postoperative recovery. The total incidence of postoperative delirium in elderly people over 60 years old undergoing non-cardiac surgery is 23.8% [23]. Cao *et al.* [24] pointed out that using propofol instead of sevoflurane can reduce the incidence of postoperative delirium in elderly patients undergoing major tumor surgery. However, there was no difference in the incidence of postoperative delirium was observed between the two groups in this study, which may be due to the exclusion of patients over 65 years old, resulting in a low overall positive rate of postoperative delirium.

This study was based on a single-center design, which limits the external validity of its results. In addition, the sample size limitation may have led to non-obvious differences in some observational results. It is necessary to conduct further multi-center, large-sample studies in the future to verify the potential advantages of total intravenous anesthesia in pulmonary tuberculosis patients undergoing general anesthesia for APC surgery.

In conclusion, compared with inhalation anesthesia, pulmonary tuberculosis patients undergoing APC surgery under total intravenous anesthesia have more stable heart rates and fewer adverse events and complications.

Conflict of Interest None

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·论　著·

全凭静脉麻醉对肺结核患者氩等离子凝固术术后早期恢复质量的影响

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摘要：目的　对比吸入麻醉和全凭静脉麻醉对行氩等离子凝固术的肺结核患者术后早期恢复质量、不良事件及术后谵妄的影响。**方法**　前瞻性选取2022年9月1日至2024年9月30日于南京市第二医院行氩等离子凝固术的90例肺结核患者作为研究对象，采用随机数字法将患者分为T组和I组，每组45例。麻醉和诱导时，T组使用丙泊酚全凭静脉麻醉和常规药物，I组使用七氟烷吸入麻醉和常规药物。记录患者的一般资料、手术时间、麻醉时间、拔管时间、离室时间、补液量、生命体征、手术室内不良事件、拔管时呛咳程度，记录并比较术后7 d内的疼痛[采用疼痛视觉模拟评分(VAS)]、恶心呕吐、头晕、恢复情况[采用15项恢复质量(QoR-15)量表]、谵妄发生[采用意识模糊评估法(CAM-ICU)]情况。**结果**　两组患者的平均动脉压(MAP)、心率和外周血氧饱和度(SpO_2)均存在显著时间效应($P<0.05$)，但组间效应和交互效应无统计学意义($P>0.05$)。两两比较发现，诱导后两组MAP均下降($P<0.05$)；离室时T组心率低于I组，两组术中均降低，但I组离室时反超麻醉前($P<0.05$)。诱导后两组SpO_2升高，但在离室时低于麻醉前($P<0.05$)。两组间低血压、高血压、低氧血症、心动过缓的发生率差异无统计学意义($P>0.05$)，T组心动过速(15.56% *vs* 62.22%，$\chi^2=20.618$，$P<0.01$)的发生率低于I组。两组拔管时呛咳程度差异无统计学意义($Z=1.567$，$P=0.117$)。两组间VAS、QoR-15评分差异无统计学意义($P>0.05$)，与术前1 d相比，两组术后第1天和术后第2天的QoR-15评分降低($P<0.05$)。I组和T组术后第1天谵妄发生率差异无统计学意义(11.11% *vs* 8.89%，$\chi^2=0.123$，$P=0.725$)。T组头晕的发生率在术后4 h低于I组，恶心呕吐发生率在术后2 h、4 h、6 h低于I组($P<0.05$)。**结论**　对于行氩等离子凝固术的肺结核患者，全凭静脉麻醉相比吸入麻醉，显示出更为稳定的血压和心率控制，以及有更低的恶心呕吐和头晕发生率。

关键词：吸入麻醉；全凭静脉麻醉；氩等离子凝固术；肺结核；平均动脉压；术后谵妄；血氧饱和度

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Total intravenous anesthesia on the quality of early recovery in patients with pulmonary tuberculosis undergoing argon plasma coagulation

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Abstract: Objective　To compare the effects of total intravenous anesthesia (TIVA) and inhalation anesthesia on early postoperative recovery quality, adverse events and postoperative deliriurn in patients with pulmonary tuberculosis undergoing argon plasma coagulation (APC). **Methods**　A total of 90 pulmonary tuberculosis patients who underwent APC at Second Hospital of Nanjing from September 1st, 2022, to September 30th, 2024, were prospectively selected. The patients were randomly divided into Group T and Group I, with 45 patients in each group. In the Group T, propofol-

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based TIVA and routine medications were used for anesthesia induction, while in the Group I, sevoflurane-based inhalation anesthesia and routine medications were used. The following parameters were recorded: general data, surgery duration, anesthesia duration, extubation time, time to leave the operating room, fluid replacement volume, vital signs, intraoperative adverse events, and cough intensity during extubation. Postoperative recovery was assessed over the first 7 days, including pain [using the Visual Analog Scale (VAS)], nausea and vomiting, dizziness, recovery quality [using the 15-item Quality of Recovery (QoR-15) scale], and the occurrence of delirium [using the Confusion Assessment Method for the Intensive Care Unit (CAM-ICU)]. **Results** There was a significant time effect on mean arterial pressure (MAP), heart rate, and saturation of peripheral oxygen (SpO_2) in both groups ($P<0.05$), but no significant group effect or interaction effect was observed ($P>0.05$). Pairwise comparisons showed that MAP decreased after induction in both groups ($P<0.05$). Heart rate was lower in Group T than in Group I when leaving the operating room, and heart rate decreased intraoperatively in both groups ($P<0.05$), but heart rate in Group I before anesthesia exceeded that when leaving the operating room ($P<0.05$); SpO_2 increased after induction but was lower before anesthesia than that when leaving the operating room ($P<0.05$). There was no significant difference in the incidence of hypotension, hypertension, hypoxemia, or bradycardia between the two groups ($P>0.05$), but the incidence rate of tachycardia was lower in Group T than that in Group I (15.56% *vs* 62.22%, $\chi^2=20.618$, $P<0.01$). There was no significant difference in cough intensity at extubation between the two groups ($Z=1.567$, $P=0.117$). There was no significant difference in VAS and QoR-15 scores between the two groups ($P>0.05$). Compared with preoperative day 1, both groups had decreased QoR-15 scores on postoperative day 1 and day 2 ($P<0.05$). There was no significant difference in the incidence of delirium on postoperative day 1 between Group I and Group T (11.11% *vs* 8.89%, $\chi^2=0.123$, $P=0.725$). The incidence of dizziness in Group T was significantly lower than that in Group I at 4 hours postoperatively ($P<0.05$). Similarly, the incidences of nausea and vomiting were significantly lower in Group T compared to Group I at 2, 4, and 6 hours postoperatively ($P<0.05$). **Conclusion** In pulmonary tuberculosis patients undergoing APC, TIVA showed more stable blood pressure and heart rate control compared to inhalation anesthesia, as well as a lower incidence of nausea, vomiting, and dizziness.

Keywords: Inhalation anesthesia; Total intravenous anesthesia; Argon plasma coagulation; Pulmonary tuberculosis; Mean arterial pressure; Postoperative delirium; Oxygen saturation

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肺结核作为一种严重的传染性疾病，是全球范围内的重要公共卫生问题。根据世界卫生组织发布的《2024年全球结核病报告》，2023年全球结核病估算发病数为1 080万；尽管抗结核药物治疗已取得显著进展，每年仍导致全球125万人死亡[1]。对于抗药性结核病或并发气道阻塞的患者，传统的药物治疗已难以满足临床需求。氩等离子凝固术（argon plasma coagulation，APC）作为一种微创治疗方法，在气道狭窄、瘢痕修复及结核性病灶清除方面显示出良好的疗效[2]。此类手术需在全身麻醉的条件下实施，而麻醉策略的选择对患者的术后康复过程具有显著影响。

麻醉药物作用于呼吸、循环、消化、神经、免疫等系统，对手术结局和患者的康复有着显著的潜在影响[3-7]。吸入麻醉（inhalation anesthesia，IA）和全凭静脉麻醉（total intravenous anesthesia，TIVA）是临床上常用的两种麻醉方式，它们对患者术中生理状态、术后恢复及并发症发生率的影响具有显著差异[3-4]。然而，关于这两种麻醉方式对肺结核患者接受APC术后恢复情况具体影响，尚缺乏系统性的临床研究。本研究旨在比较IA和TIVA对肺结核患者APC术后早期恢复情况的影响。

1 资料与方法

1.1 一般资料 本研究为单中心的随机对照试验，获得了南京市第二医院伦理委员会的批准（批件号：2022-LS-ky024），研究方案符合《赫尔辛基宣言》。所有方法均按照相关指南和规定进行，已获得所有受试者的确认知情同意。招募在2022年9月1日至2024年9月30日期间于南京市第二医院行APC的肺结核患者。（1）纳入标准：①年龄18~65岁；②美国麻醉医师协会（American Society of Anesthesiologists，ASA）分级 Ⅰ~Ⅲ级；③身体质量指数（body mass index，BMI）18~28 kg/m^2；④患者及其家属对研究内容知情并同意。（2）排除标准：①后期诊断非肺结核；②合并高血压、糖尿病等基础疾病；③对研究药物过敏；④语言、精神或理解能力障碍；⑤有药物依赖和酒精滥用史；⑥术前主要器官功能障碍。采用

随机数字表法将患者分为TIVA组(T组)和IA组(I组),患者和随访人员均对所采用的麻醉方式不知情。

1.2　麻醉方法　两组肺结核患者术前均要求禁食8 h,禁饮4 h。入室后行常规生命体征及脑电双频指数(bispectral index, BIS)监测、开放外周静脉通路,予以输注醋酸钠林格注射液(湖北多瑞药业,批号:B22041104)。两组患者诱导时开始面罩吸氧,均给予咪达唑仑(江苏恩华药业,批号:MD220406)0.04 mg/kg、舒芬太尼(宜昌人福药业,批号:21A11171)0.5 μg/kg、罗库溴铵(浙江仙琚制药,批号:210305)0.6 mg/kg。T组使用丙泊酚(西安力邦制药,批号:22205121)1.5~2.5 mg/kg;I组吸入2%~6%的七氟烷(江苏恒瑞医药,批号:22011031),至BIS≤60,使用8.0号导管进行气管插管。设置通气参数:潮气量7 mg/kg,呼吸频率12次/min,吸呼比1∶2,氧气流量1 L/min,空气流量3 L/min。手术开始时经纤维支气管镜注入2%的利多卡因(山东华鲁制药,批号:D22D17-1)5 mL在声门和气管内局部浸润。T组使用丙泊酚4~6 mg·kg^{-1}·h^{-1}及瑞芬太尼(国药集团有限公司廊坊分公司,批号:20220701)0.01 mg·kg^{-1}·h^{-1},I组使用七氟烷1.7%~4%和瑞芬太尼0.01 mg·kg^{-1}·h^{-1},以维持术中BIS值的稳定,手术结束时停止给药,在手术间等待苏醒。

1.3　观察指标

1.3.1　一般资料　包括性别、年龄、BMI、ASA分级,以及是否合并贫血或肝功能异常。

1.3.2　手术麻醉一般指标　记录手术时间、麻醉时间、拔管时间、离室时间、补液量、生命体征、手术室内不良事件、拔管时呛咳程度。拔管时间定义为从手术结束到拔管的时长。离室时间定义为从手术结束到离开手术室的时长。低血压定义为平均动脉压(mean arterial pressure, MAP)<60 mmHg或收缩压较基础值降低幅度≥20%。呼吸抑制定义为外周血氧饱和度(saturation of peripheral oxygen, SpO_2)<90%。拔管时呛咳程度参考Minogue等[8]的方法,将呛咳严重程度分为3个程度,轻度为单次呛咳,中度为不止1次≤5 s的咳嗽,重度持续为≥5 s的咳嗽。

1.3.3　术后疼痛、恶心呕吐、头晕发生情况　在术后2、4、6 h和术后第1天、第2天、第3天、第5天、第7天进行疼痛视觉模拟量表(Visual Analogue Scale, VAS)评分,同时记录恶心呕吐、头晕的发生。VAS评分中,0分表示无痛,10分代表难以忍受的最剧烈的疼痛。

1.3.4　恢复情况　在术前1天以及术后的第1天、第2天、第3天、第5天、第7天6个时间点采用15项恢复质量(15-item Quality of Recovery, QoR-15)量表[9]评估恢复质量,量表设有满分150分,其中得分越高提示患者术后恢复质量越优。

1.3.5　术后谵妄　在术后第1天、第2天、第3天、第5天、第7天5个时间点,通过重症监护病房意识模糊评估法(Confusion Assessment Method for the Intensive Care Unit, CAM-ICU)[10]对术后谵妄进行随访评估。

1.4　统计学方法　采用PASS 15软件对前期预试验的趋势检验进行计算,T组术后恶心呕吐的发生率为30%,I组为60%,设双边α=0.05,1−β=0.8,计算得到拟纳入患者82例,每组41例,预计10%的脱落率,每组初始需分配45例。采用SPSS 25.0软件进行统计学分析。符合正态分布的连续变量以$\bar{x}\pm s$表示,组间比较采用独立样本t检验,多个时点比较用重复测量方差分析,两两比较用LSD-t检验。非正态分布的连续变量以$M(Q_1,Q_3)$表示,并使用Mann-Whitney U检验进行组间比较。分类变量以例(%)表示,采用χ^2检验或Fisher确切概率检验进行比较。对于多个时点的非正态及分类变量资料比较采用广义估计方程,使用Friedman检验和Wilcoxon符号秩检验进行组内不同时间点的简单效应分析,使用Mann-Whitney U检验对同一时间点不同组的数据进行比较。P<0.05为差异有统计学意义。

2　结　果

2.1　两组患者一般情况的比较　本研究共筛查了139例接受APC手术的患者,随后根据纳入和排除标准,排除了34例患者。此外,15例后续被诊断为非肺结核或因失访而无法追踪的患者也被剔除。最终,纳入分析的受试者共有90例,其中每组各45例。两组患者在性别、年龄、BMI、ASA分级、合并症、手术时间、麻醉时间、拔管时间、离室时间以及补液量方面差异均无统计学意义(P>0.05)。见表1、表2。

2.2　两组患者围手术期生命体征的比较　两组患者的MAP、心率、SpO_2均存在时间效应(P<0.01),组间效应和交互效应无统计学意义(P>0.05)。见表3。两两比较分析发现,与麻醉前基线相比,T组患者在诱导后(P<0.01)、手术开始时(P<0.01)、手术结束时(P<0.01)以及离室时(P=0.012)的MAP明显降低,I组患者则在诱导后、手术开始时和手术结束时出现MAP下降(P<0.05)。

在心率方面，组间比较显示离室时T组低于I组（t=2.413，P=0.018）；时间点比较发现，T组患者手术结束时心率较麻醉前降低（P=0.022），I组患者在诱导后（P=0.020）、手术开始时（P=0.031）和手术结束时（P=0.004）的心率均低于麻醉前水平，但在离室时反而显著高于基线（P=0.009）。

在SpO_2方面，T组在诱导后升高（Z=1.333，P<0.01），但在离室时低于麻醉前水平（Z=1.578，P<0.01）；I组则在诱导后（Z=1.456，P<0.01）和手术开始时（Z=0.967，P<0.01）升高，离室时（Z=1.356，P<0.01）降低。

2.3　两组不良事件的比较　低血压、高血压、低氧血症及心动过缓的发生率在两组间差异无统计学意义（P>0.05）；T组心动过速的发生率明显低于I组，差异有统计学意义（P<0.01）。见表4。

2.4　拔管时呛咳程度的比较　T组呛咳轻度7例，中度13例，重度2例。I组呛咳轻度6例，中度17例，重度8例。两组拔管时呛咳程度差异无统计学意义（Z=1.567，P=0.117）。

2.5　不同时间点VAS评分的比较　两组患者术后静息时VAS评分的时间主效应显著（P<0.01），而组间主效应（P=0.784）及时间×组间的交互效应（P=0.236）均无统计学意义。活动时VAS评分的时间主效应（P<0.01）及时间×组间的交互效应（P=0.009）显著，但组间主效应无统计学意义（P=0.617）。两两比较发现，不同时间点两组间活动时VAS评分差异均无统计学意义（P>0.05）。见表5。

2.6　不同时间点QoR-15评分的比较　患者QoR-15评分的时间主效应显著（P<0.01），术后较术前明显改善，但组间主效应及时间×组间的交互效应均无统计学意义（P>0.05）。与术前1 d相比，两组患者在术后第1天（T组：Z=2.933，P<0.01；I组：Z=2.756，P<0.01）和第2天（T组：Z=1.667，P<0.01；I组：Z=1.544，P<0.01）的QoR-15评分显著降低。见表6。

2.7　不同时间点术后谵妄发生率的比较　在术后第1天两组患者均观察到最多的术后谵妄发生，其中T组3例，而I组4例；至术后第2天，两组各报告1例术后谵妄病例。两组间术后谵妄发生率差异无统计学意义（11.11% *vs* 8.89%，χ^2=0.123，P=0.725）。

2.8　不同时间点头晕、恶心呕吐的比较　两组头晕症状的严重程度随时间变化（P<0.01），且组间差异明显（P<0.01），时间×组间的交互作用亦显著（P<0.01）。通过简单效应分析，在术后4 h，T组头晕的发生率低于I组（χ^2=4.121，P=0.042）。术后恶心呕吐的发生率存在时间效应、组间效应及时间×组间的交互效应（P<0.01）。与I组相比，T组的恶心呕吐发生率在术

表1　两组一般资料比较　（n=45）

Tab.1　Comparison of the general data between two groups （n=45）

组别	男/女（例）	年龄[岁，$M(Q_1,Q_3)$]	BMI（kg/m²，$\bar{x}\pm s$）	ASA Ⅱ/Ⅲ级（例）	贫血（例）	肝功能异常（例）
T组	18/27	42（32，56）	21.99±2.48	44/1	1	4
I组	16/29	43（29，56）	21.63±2.48	43/2	1	5
$\chi^2/Z/t$值	0.189	0.057	0.676			
P值	0.664	0.955	0.501	1.000[a]	1.000[a]	1.000[a]

注：[a]采用Fisher确切概率法。

表2　两组手术麻醉一般指标的比较　[n=45，$M(Q_1,Q_3)$]

Tab.2　Comparison of general indicators of surgical anesthesia between two groups　[n=45，$M(Q_1,Q_3)$]

组别	手术时间（min）	麻醉时间（min）	拔管时间（min）	离室时间（min）	补液量（mL）
T组	30.0（21.0，40.0）	40.0（30.5，52.5）	20.0（15.0，26.0）	40.0（35.0，47.5）	400.0（350.0，450.0）
I组	27.0（16.0，39.5）	35.0（29.0，45.0）	20.0（15.0，25.0）	40.0（32.5，45.0）	400.0（350.0，450.0）
Z值	1.339	1.395	1.102	0.949	1.169
P值	0.181	0.163	0.271	0.343	0.242

表3　两组生命体征的比较　（n=45）

Tab.3　Comparison of vital signs between two groups　（n=45）

时间点	MAP（mmHg，$\bar{x}\pm s$）		心率（次/min，$\bar{x}\pm s$）		SpO_2[%，$M(Q_1,Q_3)$]	
	T组	I组	T组	I组	T组	I组
麻醉前	89.24±10.23	87.82±11.53	81.58±11.77	83.29±13.97	98（97，99）	98（96，98）
诱导后	79.84±8.91[a]	81.38±9.65[a]	76.73±10.83	76.67±15.77[a]	100（99，100）[a]	100（99，100）[a]
手术开始时	78.73±11.65[a]	81.49±11.46[a]	83.29±5.95	81.58±6.91[a]	99（98，100）	99（98，100）[a]
手术结束时	71.96±7.61[a]	75.18±9.06[a]	74.02±11.20[a]	75.93±15.04[a]	98（96，99）	97（96，98）
离室时	85.02±10.54[a]	85.93±12.26	82.80±14.18	89.64±12.68[ab]	94（94，96）[a]	95（93，96）[a]
$F/\chi^2_{组间/时间/交互}$值	0.949/41.446/0.915		1.759/15.036/1.151		2.815/328.930/5.779	
$P_{组间/时间/交互}$值	0.333/<0.001/0.459		0.188/<0.001/0.332		0.093/<0.001/0.216	

注：与同组麻醉前比较，[a]P<0.05；与T组比较，[b]P<0.05。

后2 h(χ^2=8.715,P=0.003)、4 h(χ^2=7.511,P=0.006)、6 h(χ^2=5.475,P=0.019)较低,但随着时间推移,两组差异逐渐减小,至术后第1天差异无统计学意义(χ^2=1.011,P=0.315)。术后第3、5、7天未观察到头晕、恶心呕吐发生。见表7。

表4　两组不良事件的比较　[n=45,例(%)]

Tab.4　Comparison of adverse events between two groups [n=45, case(%)]

组别	低血压	高血压	低氧血症	心动过缓	心动过速
T组	25(55.56)	4(8.89)	7(15.56)	2(4.44)	7(15.56)
I组	33(73.33)	10(22.22)	5(11.11)	2(4.44)	28(62.22)
χ^2值	3.103	3.045	0.385		20.618
P值	0.078	0.081	0.535	1.000[a]	<0.001

注:[a]采用Fisher确切概率法。

表5　两组患者术后VAS评分　[n=45,$M(Q_1,Q_3)$]

Tab.5　Comparison of postoperative VAS scores between two groups　[n=45, $M(Q_1,Q_3)$]

时间点	VAS静息		VAS活动	
	T组	I组	T组	I组
术后2 h	1.0(0.5,3.0)	2.0(1.0,3.0)	3.0(2.0,4.0)	3.0(2.0,5.0)
术后4 h	2.0(1.0,3.0)	2.0(1.0,3.0)	3.0(2.0,4.0)	3.0(2.0,5.0)
术后6 h	1.0(0.5,2.5)	2.0(0.5,3.0)	3.0(2.0,3.5)	3.0(2.0,5.0)
术后第1天	0(0,1.0)	0(0,1.0)	1.0(1.0,2.0)	1.0(0,2.5)
术后第2天	0(0,0.5)	0(0,0)	1.0(0,1.0)	0(0,1.0)
术后第3天	0(0,0)	0(0,0)	0(0,1.0)	0(0,0)
术后第5天	0(0,0)	0(0,0)	0(0,0)	0(0,0)
术后第7天	0(0,0)	0(0,0)	0(0,0)	0(0,0)
$\chi^2/P_{时间}$值	171.056/<0.001		307.550/<0.001	
$\chi^2/P_{组间}$值	0.075/0.784		0.251/0.617	
$\chi^2/P_{交互}$值	8.034/0.236		17.078/0.009	

表6　两组患者不同时间点QoR-15评分的比较　[n=45, $M(Q_1,Q_3)$]

Tab.6　Comparison of QoR-15 scores between two groups at different time points　[n=45,$M(Q_1,Q_3)$]

组别	术前1天	术后第1天	术后第2天	术后第3天	术后第5天	术后第7天
T组	142(140, 144)	134(130, 140)[a]	139(135, 142)[a]	140(139, 143)	141(140, 145)	143(140, 145)
I组	142(138, 144)	135(132, 140)[a]	140(135, 143)[a]	142(138, 144)	143(140, 145)	144(142, 145)
$\chi^2/P_{时间}$值	315.292/<0.001					
$\chi^2/P_{组间}$值	0.238/0.625					
$\chi^2/P_{交互}$值	6.577/0.254					

注:与同组术前1 d比较,[a]P<0.05。

表7　两组患者头晕、恶心呕吐情况的比较　[n=45,例(%)]

Tab.7　Comparison of dizziness, nausea and vomiting between two groups　[n=45, case (%)]

组别	头晕					恶心呕吐				
	术后2 h	术后4 h	术后6 h	术后第1天	术后第2天	术后2 h	术后4 h	术后6 h	术后第1天	术后第2天
T组	30(66.67)	26(57.78)[a]	26(57.78)	4(8.89)	0	16(35.56)[a]	16(35.56)[a]	14(31.11)[a]	0	0
I组	36(80.00)	35(77.78)	34(75.56)	6(13.33)	1(2.22)	30(66.67)	29(64.44)	25(55.56)	1(2.22)	0
$\chi^2/P_{时间}$值	1 081.214/<0.001					17 395.595/<0.001				
$\chi^2/P_{组间}$值	152.869/<0.001					225.634/<0.001				
$\chi^2/P_{交互}$值	595.552/<0.001					569.887/<0.001				

注:与同时间点I组比较,[a]P<0.05。

3　讨　论

随着医学领域的不断进步,肺结核的治疗策略亦日益多样化[1]。选择何种麻醉方案有利于肺结核患者的术后恢复,是一项值得深入探讨的关键议题。本研究发现,APC术中采用TIVA的肺结核患者群体显示出了较低的并发症、不良事件发生率。

丙泊酚具有循环系统抑制作用,其通过直接抑制心肌收缩和作用于血管平滑肌,扩张外周血管,导致血压下降[9]。吸入性麻醉药物也具有减弱心肌收缩力、降低血压的作用[11-12]。本研究结果显示,通过调整BIS数值以维持麻醉深度,两组患者的MAP差异不显,而在诱导后,患者血压均发生降低。研究证明快速吸入七氟烷不会引起心率显著增加,并能维持心输出量的稳定,对心率和血压的影响相对较小[13]。丙泊酚可以抑制、重调压力感受器反射,减弱机体对低血压的心动过速反应,也使得患者的心率改变不明显[14-15]。肺结核作为一种慢性消耗性疾病,常伴随患者呼吸功能的损害。在术后离室时,两组患者的SpO_2均低于术前,这可能是由于APC手术中的气管内操作刺激气道,影响了呼吸功能。丙泊酚可有效治疗术后恶心,并用于治疗顽固性恶心呕吐,其效果可持续数个小时,本研究中静脉麻醉组患者的情况与之前研究结果一致[16]。七氟烷能扩张脑血管,

增加脑血流量和颅内压，而丙泊酚则能降低脑血流、颅内压及脑耗氧量，这些特性可能与患者头晕感受的差异有关[17]。与Niu等[3]的结果一致，在离室时，使用静脉麻醉的患者心率低于吸入麻醉组，这或与较少的恶心呕吐和头晕感受有关。无论是七氟烷还是丙泊酚，两者均为短效药物，代谢和消除迅速，这既保证了患者的安全，也使得术后疼痛评分差异较小。

QoR-15量表作为一种评估患者术后康复质量的工具，展现出良好的信度、效度和临床适用性[18]。与Lee等[19]的研究结果相似，本研究中，T组和I组间的QoR-15评分无明显差异。鉴于APC手术相较于传统外科手术损伤较小，患者疼痛感较弱，且该术式有助于恢复气道通畅，本研究中术后第3天两组患者的QoR-15评分即回升至基线水平；而创伤较大的外科手术后5~7 d，患者尚不能完全恢复[20]。术后谵妄是老年患者中常见且严重的并发症，严重影响了术后恢复，在60岁以上接受非心脏手术的老年人群中，术后谵妄的总发生率为23.8%[21]。Cao等[22]指出，相比七氟烷使用丙泊酚可降低肿瘤大手术的老年患者术后谵妄的发生率。然而，本研究未观察到两组患者术后谵妄发生率差异的显著性，这可能是由于本研究排除了65岁以上的患者，导致术后谵妄总体阳性率较低。

本研究基于单中心设计，其结果的外部效度受到限制。此外，样本量的限制也可能导致了某些观察结果未表现出明显差异。后期有必要开展进一步的多中心、大样本量研究，以验证TIVA在肺结核患者接受全身麻醉APC手术中的潜在优势。

综上所述，在TIVA下行APC手术的肺结核患者，相较于吸入麻醉，患者心率更稳定、不良事件和并发症更少。

利益冲突　无

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