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Research Article
Significant Anesthetic Effects of Butorphanol Combined with Propofol on Ultrasonic Bronchoscopy for the Elderly

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Abstract

Background and Objective: Fiberoptic bronchoscopy is an invasive diagnosis and treatment technique. Elderly patients are prone to cardiovascular diseases and have poor tolerance to stimulation. This study aimed to assess the effects of butorphanol combined with propofol on ultrasonic bronchoscopy for the elderly. **Materials and Methods:** A total of 180 elderly patients undergoing painless ultrasonic bronchoscopy in our hospital from June, 2019 through June, 2020 were randomly assigned into Group I (propofol group, n = 60), Group II (sufentanil combined with propofol group, n = 60) and Group III (butorphanol combined with propofol group, n = 60). Hemodynamic indicators, anaesthesia, analgesia and sedative effects and adverse reactions were compared before and after anaesthesia. **Results:** Group III had significantly lower mean arterial pressure and heart rate at the time of bronchoscope entering the larynx and the end of bronchoscopy, lower propofol dose, shorter anaesthesia onset time, bronchoscopy duration and recovery time and lower ramsay score and incidence rate of adverse reactions than those of Groups I and II. The saturation of pulse oximetry in Group III at the time of bronchoscope entering the larynx and the end of bronchoscopy was significantly higher than those of Groups I and II ($p<0.05$). **Conclusion:** Butorphanol combined with propofol for induction can stabilize hemodynamic indicators, improve patient comfort and exert better anaesthesia, analgesia and sedation effects and fewer postoperative adverse reactions. Therefore, it is more suitable for ultrasonic bronchoscopy in the elderly.

Key words: Butorphanol, propofol, ultrasonic bronchoscopy, elderly, bispectral index

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Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Fiberoptic bronchoscopy is a common method for diagnosis and treatment within the thorax[1]. It is often used for the elderly population[2]. Nevertheless, the elderly have a higher rate of uncomfortable complications than that of the younger population[3]. Therefore, the necessity of employing sedation in combination with topical anaesthesia during fiberoptic bronchoscopy has been highlighted by the American College of Chest Physicians[4], which can relieve fear, anxiety and mental stress as well as improve tolerance, comfort and clinical outcomes[5].

In clinical practice, dexmedetomidine and midazolam are most commonly used for fiberoptic bronchoscopy[6]. With similar safety to that of midazolam, propofol is superior in shortening the recovery time[7], which is of great significance to the elderly[8]. Propofol is a general anaesthetic with quick onset and short duration. It can be used for many kinds of endoscopy without accumulation in the body. However, for its weak analgesic effect, propofol at a large dose may cause certain respiratory and cardiovascular depression, so it often needs to be used in combination with other opioids[9]. Both sufentanil and butorphanol are common opioids and have strong analgesic effects. In particular, butorphanol has fewer inhibitory effects on the respiratory system, thereby making up for the shortcomings of propofol[10,11].

Until now, propofol has never been combined with butorphanol to perform ultrasonic bronchoscopy for the elderly, which was thus explored in this study to provide a reference for the selection of appropriate anaesthesia methods.

MATERIALS AND METHODS

Clinical data: A total of 180 diagnosed elderly patients who underwent painless ultrasonic bronchoscopy in our hospital between June, 2019 and June, 2020 were enrolled as the research subjects. They were aged 61-78 years old and (65.86±8.43) years old on average, with a Body Mass Index (BMI) of (22.38±2.59) kg m^{-2}. According to a random number table, they were divided into Group I (propofol group), Group II (sufentanil combined with propofol group) and Group III (butorphanol combined with propofol group), with 60 cases in each group. The present study was reviewed and approved by the Ethics Committee of our hospital and the test methods were in strict accordance with the relevant experimental regulations. The research subjects and their family members were informed of the relevant rights and risks voluntarily participated in the present study and signed the informed consent.

Inclusion and exclusion criteria: The inclusion criteria were set as follows:

- Patients who were aged 60-80 years old, had normal consciousness and needed ultrasonic bronchoscopy
- Those with the American Society of Anesthesiologists (ASA) class
- Those with normal preoperative blood routine, coagulation function, electrocardiogram and lung function test results
- Those with no history of allergies or adverse reactions to the sedatives and analgesics used
- Those with no difficult airway

The exclusion criteria were set as follows:

- Patients who were not suitable for conventional bronchoscopy
- Those with severe liver or kidney dysfunction
- Those with tracheal stenosis that might cause asphyxia during intracavitary ultrascope
- Those undergoing craniocerebral trauma surgeries
- Those who were unwilling to receive sedation and analgesia or
- Those with incomplete case data or loss to follow-up

Collection of baseline data: Baseline data collection and related index determination were completed by all medical staff in our department and all participating researchers received unified training and passed training exams before the research, so the index evaluation could meet a unified standard. The baseline data, including age, height, weight and ASA classification were collected and BMI was calculated based on the height and weight:

$$\text{BMI} = \frac{\text{Weight (kg)}}{\text{Height}^2\ (\text{m}^2)}$$

The colour Doppler ultrasonic diagnostic apparatus ACUSON Sequoia (USA) was used for detecting the cardiac function indices: Left Ventricular Ejection Fraction (LVEF) and Left Ventricular End Diastolic Diameter (LVEDD) and the spirometer Master screen Diff (Germany) was applied to detect the pulmonary function indices: Forced expiratory volume in 1 s (FEV1), Forced Vital Capacity (FVC) and FEV1/FVC ratio.

Anaesthesia methods: Before the operation, all the patients were deprived of food for 6 hrs and water for 4 hrs. Upon entering the operating room, an 18 G in dwelling needle in the upper limb vein was used to establish venous access, followed by intravenous dripping of 6 mL kg^{-1} Ringer's sodium lactate solution (China Otsuka Pharmaceutical Co., Ltd., batch No.: 7G69A9). A DETEX Multi-function monitor was then connected to routinely monitor the Electrocardiogram (ECG), a Saturation of Pulse Oximetry (SpO_2), Heart Rate (HR) and blood pressure to observe the respiration and the anaesthesia was monitored with the Bispectral Index (BIS) monitor. After resting for 10 min, SpO_2, Mean Arterial Pressure (MAP), HR and BIS were recorded every 2 min and the average value of 3 measurements was taken as the value before administration (T_0). The patients in Group I were slowly given butorphanol (Jiangsu Hengrui Pharmaceuticals Co., Ltd., batch No.: 18061826) at a dose of 15 μg kg^{-1} through the peripheral vein before bronchoscopy, those in Group II were anaesthetized with propofol (Beijing Fresenius Kabi Pharmaceutical Co., Ltd., batch No.: 18FE0072) at a dose of 1.8-2.5 mg kg^{-1} and those in Group III were slowly given butorphanol at 10 μg kg^{-1} before bronchoscopy and propofol at 1.5-2.0 mg kg^{-1} after 3 min through the peripheral vein. Normal saline was diluted to 10 mL and intravenously pumped for 10 min at a rate of 0.5 μg kg^{-1} h). After intravenous general anaesthesia, the operation was started once the patient's eyelash reflexes disappeared. If the patient had physical movement or coughing reaction, 1-3 mL of l% lidocaine was instilled into the airway. If significant respiratory depression occurred during the operation (SpO_2<90%), the ultrasonic bronchoscope was withdrawn and pressurized oxygen was given by a mask. Ultrasonic bronchoscopy was completed by the same group of senior doctors in the Respiratory Department of our hospital for all the patients.

Hemodynamic indicators: The MAP, HR and SpO_2 were recorded before administration (T_0), before the entry of the bronchoscope (T_1), at the time of passing the larynx (T_2), at the end of bronchoscopy (T_3) and 5 min (T_4) and 15 min (T_5) after bronchoscopy.

Evaluation of anaesthetic efficacy: The propofol dose, bronchoscopy duration, anaesthesia onset time and recovery time were recorded in each group and the anaesthetic efficacy was evaluated. According to the literature[6], the efficacy was evaluated as three grades: Excellent, moderate and poor. When the glottis was well open, the fiberoptic bronchoscope could be easily inserted and the patient had no cough, excellent efficacy was defined. Moderate efficacy referred to the conditions that the glottis was well open, the fiberoptic bronchoscope could be inserted smoothly and the patient had a mild cough. When the glottis was closed and the patient suffered from the obvious cough or body movement, the efficacy was poor[12].

Assessment of analgesic and sedative effects: Visual Analog Scale (VAS) based on facial expressions and Bruggemann Comfort Scale (BCS) were used to assess the analgesic effects of patients at T_0, T_4, T_5, 1 hr (T_6) and 4 hrs (T_7) after bronchoscopy. Besides, the sedative effect was evaluated by the Ramsay sedation scale:

- VAS score was given as follows: The total score was 0-10 points and 0 points stood for painlessness, 3 points or less for mild pain that patients could tolerate, 4-6 points for moderate pain that affected sleep but patients could tolerate, 7-10 points for severe pain, suggesting no analgesic effect
- BCS scores were set as follows: 0 points stood for persistent pain, 1 point for no pain in the quiet situation and worsened pain at the time of deep breathing and coughing, 2 points for no pain when the patient lay flat and mild pain at the time of deep breathing and coughing, 3 points for no pain in case of deep inspiration and 4 points for no pain when the patient coughed hard
- In terms of ramsay scores, 1-2 points indicated insufficient sedation, 3-4 points satisfactory sedation and 5-6 points excessive sedation

Postoperative adverse reaction indicators: The occurrence of adverse reactions and complications during anaesthesia were observed in each group of patients, including dizziness, nausea, vomiting, tachycardia (HR>100 beats min^{-1}), respiratory depression (SpO_2<90%) and emergence agitation and the number of cases of adverse reactions in each group was recorded.

Statistical analysis: SPSS 19.0 software was used for statistical analysis. Measurement data were represented as Mean±Standard deviation and compared between 2 groups using independent samples t-test and among multiple groups by analysis of variance. Numerical data were expressed as [n (%)] and the χ^2 test and Fisher's exact test were used for comparison between groups. The difference was statistically significant at two-tailed $p<0.05$.

RESULTS

Baseline data: The basic data of patients were compared among the three groups and there was no significant difference in age, sex, weight, BMI, ASA classification, heart function (LVEF and LVEDD), lung function (FEV1, FVC and FEV1/FVC ratio) ($p>0.05$) in Table 1.

Hemodynamic indices and BIS: HR reflects the ability of the heart pumping to compensate for changes in metabolism, stress response, volume and heart function changes (normal value: 60-100 beats min^{-1}). MAP is the average arterial blood pressure in a cardiac cycle, which reflects the perfusion volume of organs (normal value of adults: 70-105 mmHg). BIS reflects the functional status of the cerebral cortex, which can accurately determine the depth of anaesthesia (normal value: 85-100). SpO_2 can usually reflect the oxygenation state in a timely and reliable manner (normal value: >95%). The BIS values in the three groups were in the normal anaesthesia range at each time point, which was similar ($p>0.05$) and there were no significant differences in MAP, HR and SpO_2 in the three groups at T_0 and T_1 ($p>0.05$). Compared with those at T_0, MAP and HR increased to varying degrees (MAP from T_2-T_4: Group I: 109.16±6.95, 103.51±7.94, 91.83±6.99 mmHg, Group II: 93.06±7.22, 90.62±7.20, 86.54±7.10, Group III: 90.41±7.14, 87.15±7.21, 83.27±7.28. HR from T_2-T_4: Group I: 98.76±7.13, 91.16±7.04, 84.72±7.11 beats min^{-1}, Group II: 94.38±7.32, 87.18±7.26, 80.21±7.09 beats min^{-1}, Group III: 90.53±7.15, 81.23±7.12, 75.70±7.05 beats min^{-1}) and SpO_2 decreased to varying degrees at T_2-T_4 in all the groups (from T_2- T_4: Group I: 94.03±1.48, 95.36±1.54, 96.23±1.47%, Group II: 96.28±1.35, 96.52±1.53, 96.74±1.42%, Group III: 96.85±1.4, 96.89±1.62, 96.92±1.59%). Group III had significantly lower MAP and HR but significantly higher SpO_2 than Groups I and II at T_2-T_3 ($p<0.05$) showed in Table 2.

Anaesthetic efficacy: Groups II and III had significantly lower total propofol dose (272.31±53.34, 253.58±42.25 mg), shorter anaesthesia onset time (25.08±8.07, 20.02±9.21 s), bronchoscopy duration (45.51±3.02, 47.19±3.06 min) and recovery time (4.12±0.51, 3.09±0.48 min) and better anaesthetic efficacy than those of Group I (291.56±48.67 mg, 33.22±8.86 s, 50.62±3.15 min, 6.53±1.43 min) ($p<0.05$) in Table 3.

Analgesic and sedative effects: There was no significant difference in VAS score, BCS score and Ramsay score among the three groups at T_0 and T_7 ($p>0.05$). At T_4-T_6, the above scores in Group II and Group III (VAS score from T_4-T_6: Group II: 3.17±0.81, 2.56±0.75, 1.94±0.80, Group III: 3.09±0.86, 2.52±0.74, 1.82±0.76. BCS score from T_4-T_6: Group II: 2.48±0.83, 2.85±0.80, 3.42±0.81, Group III: 2.52±0.80, 2.88±0.79, 3.51±0.78. Ramsay score from T_4-T_6: Group II: 2.75±0.72, 3.09±0.72, 3.54±0.78, Group III: 3.23±0.70, 3.48±0.71, 3.85±0.81) were significantly different from those in Group I (VAS score from T_4-T_6: 3.43±0.86, 2.85±0.78, 2.43±0.85. BCS score from T_4-T_6: 2.13±0.71, 2.54±0.83, 3.09±0.79. Ramsay score from T_4-T_6: 2.42±0.69, 2.66±0.70, 3.32±0.76) ($p<0.05$). At T_4-T5, the Ramsay score in Group II was significantly lower than that in Group III ($p<0.05$) in Table 4.

Incidence of adverse reactions: The incidence of adverse reactions was compared among the three groups and it was found that Group I had a significantly higher incidence rate of respiratory (21.67%) than Groups II (1.67%) and III (0) ($p<0.05$). The incidence rate of adverse reactions in Groups I, II and III was 36.67, 18.33 and 6.67%, respectively, which was significantly lower in Groups II and III than that in Group I ($p<0.05$). The incidence rate of nausea and vomiting in Group III (0) was significantly lower than that in Group II (10.00%) ($p<0.05$) in Table 5.

Table 1: Baseline data

Index	Group I (n = 60)	Group II (n = 60)	Group III (n = 60)	F/χ^2	p-value
Age (year)	65.94±8.24	66.01±8.21	65.67±8.35	1.396	0.817
Sex [male/female (n)]	32/28	33/27	32/28	0.278	0.964
Weight (kg)	62.85±6.28	63.12±7.02	63.26±6.86	0.934	0.910
BMI (kg m^{-2})	24.89±2.14	24.67±2.32	25.02±2.08	1.223	0.822
ASA class II/III (n)	27/33	25/35	29/31	2.779	0.427
LVEF (%)	55.66±3.11	54.67±3.12	56.13±3.12	1.242	0.831
LVEDD (mm)	47.28±3.11	47.52±3.23	47.36±3.24	1.362	0.837
FEV1 (L)	1.78±0.22	1.79±0.31	1.77±0.28	0.925	0.934
FVC (L)	2.25±0.21	2.24±0.21	2.24±0.22	1.351	0.852
FEV1/FVC ratio (%)	84.31±2.51	84.52±2.32	84.45±2.42	1.419	0.316

ASA: American society of anesthesiologists, BMI: Body mass index, FEV1: Forced expiratory volume in 1 s, FVC: Forced vital capacity, LVEDD: Left ventricular end-diastolic diameter and LVEF: Left ventricular ejection fraction

Table 2: Hemodynamic indicators ($\bar{\chi}\pm s$)

Index	Groups	T_0	T_1	T_2	T_3	T_4	T_5
MAP (mmHg)	I	82.36±6.92	80.82±6.98	109.16±6.95*	103.51±7.94*	91.83±6.99*	83.66±7.97
	II	82.42±7.12	80.51±7.20	93.06±7.22*#	90.62±7.20*#	86.54±7.10*#	82.32±7.02
	III	83.21±7.08	80.63±7.03	90.41±7.14*#Δ	87.15±7.21*#Δ	83.27±7.28#Δ	81.13±6.87
HR (beats min^{-1})	I	73.74±7.15	71.18±7.02	98.76±7.13*	91.16±7.04*	84.72±7.11*	74.23±7.05
	II	73.81±7.24	70.92±7.11	94.38±7.32*#	87.18±7.26*#	80.21±7.09*#	73.30±7.16
	III	73.73±7.16	71.20±7.12	90.53±7.15*#Δ	81.23±7.12*#Δ	75.70±7.05#Δ	72.36±7.02
SpO_2 (%)	I	96.74±1.39	97.09±1.42	94.03±1.48*	95.36±1.54*	96.23±1.47	96.62±1.71
	II	96.63±1.54	97.01±1.29	96.28±1.35#	96.52±1.53#	96.74±1.42	96.95±1.63
	III	96.69±1.52	97.03±1.40	96.85±1.41#Δ	96.89±1.62#Δ	96.92±1.59#	97.02±1.58
BIS	I	94.28±5.41	48.05±5.21	46.16±5.43	48.15±5.14	70.27±5.12	93.96±5.31
	II	93.89±5.23	47.96±5.22	46.38±5.38	48.71±5.22	71.23±5.09	94.03±5.26
	III	94.13±5.61	47.85±5.15	46.23±5.51	48.17±5.26	71.17±5.05	94.32±5.12

BIS: Bispectral index; HR: Heart rate, MAP: Mean arterial pressure, SpO_2: Saturation of pulse oximetry. After resting for 10 min, SpO_2, (MAP) , *p<0.05 vs. T_0, #p<0.05 vs. Group I and Δp<0.05 vs. Group II

Table 3: Anesthetic efficacy ($\bar{\chi}\pm s$)

Index	Group I (n = 60)	Group II (n = 60)	Group III (n = 60)	F	p-value
Total dose of propofol (mg)	291.56±48.67	272.31±53.34*	253.58±42.25*#	5.67	0.041
Anesthesia onset time (s)	33.22±8.86	25.08±8.07*	20.02±9.21*#	6.32	0.034
Bronchoscopy duration (min)	50.62±3.15	45.51±3.02*	47.19±3.06*#	5.95	0.039
Recovery time (min)	6.53±1.43	4.12±0.51*	3.09±0.48*#	7.12	0.028
Anaesthetic efficacy				11.472	0.000
Excellent	42 (75.00)	54 (90.00)*	57 (93.33)*		
Moderate	11 (13.33)	5 (8.33)	4 (6.67)		
Poor	7 (11.67)	1 (3.33)	0 (0)		

*p<0.05 vs. Group I and #p<0.05 vs. Group II

Table 4: Analgesic and sedative effects [n (%)]

Index	Groups	T_0	T_4	T_5	T_6	T_7
VAS score	I	1.52±0.83	3.43±0.86*	2.85±0.78*	2.43±0.85*	1.54±0.89
	II	1.54±0.87	3.17±0.81*#	2.56±0.75*#	1.94±0.80*#	1.55±0.85
	III	1.53±0.82	3.09±0.86*#	2.52±0.74*#	1.82±0.76*#	1.53±0.79
BCS score	I	3.53±0.84	2.13±0.71*	2.54±0.83*	3.09±0.79*	3.54±0.83
	II	3.58±0.82	2.48±0.83*#	2.85±0.80*#	3.42±0.81#	3.57±0.80
	III	3.56±0.85	2.52±0.80*#	2.88±0.79*#	3.51±0.78#	3.56±0.79
Ramsay score	I	4.00±0.00	2.42±0.69*	2.66±0.70*	3.32±0.76*	3.84±0.80
	II	4.00±0.00	2.75±0.72*#	3.09±0.72*#	3.54±0.78*	3.86±0.78
	III	4.00±0.00	3.23±0.70*#Δ	3.48±0.71*#Δ	3.85±0.81#Δ	3.92±0.79

BCS: Bruggemann comfort scale, VAS: Visual analog scale, *p<0.05 vs. T_0 , #p<0.05 vs. Group II and Δp<0.05 vs. Group II

Table 5: Adverse reactions [n (%)]

Adverse reaction	Group I (n = 60)	Group II (n = 60)	Group III (n = 60)	χ^2	p-value
Dizziness	3 (5.00)	2 (3.33)	3 (5.00)	0.262	0.877
Nausea and vomiting	2 (3.33)	6 (10.00)	0 (0)#	7.326	0.026
Tachycardia	2 (3.33)	2 (3.33)	1 (1.67)	0.411	0.814
Respiratory depression	13 (21.67)	1 (1.67)*	0 (0)*	24.320	0.000
Emergence agitation	2 (3.33)	0 (0)	0 (0)	4.045	0.132
Total	22 (36.67)	11 (18.33)*	4 (6.67)*	16.806	0.000

*p<0.05 vs. Group I and #p<0.05 vs. Group II

DISCUSSION

The strong stimulation of the respiratory tract by fiberoptic bronchoscopy tends to cause damage to the patient's psychology and spirit and make the patient fearful. At the same time, it may induce arrhythmia, acute heart failure and other adverse consequences even for ordinary patients[13]. According to a previous study[14], a favourable anaesthesia method can not only alleviate the adverse reactions of the patient's respiratory tract and cardiac vessels but also shorten the operation duration.

Propofol has been widely used in microscopic anaesthesia, its combination with other opioids can reduce its inhibitory effect on the respiratory system[15]. Sufentanil, a

μ-opioid receptor, has a significant analgesic effect and its combination with propofol can enhance the anaesthetic potency[16]. Butorphanol has a clear analgesic effect, which is 4-8 times that of morphine and fewer effects on respiration, only 1/5 that of morphine. As a mixed opioid agonist-antagonist, both butorphanol and its metabolites can stimulate κ-opioid receptors in the central nervous system and have the dual agonist-antagonist effects on μ-receptors[17]. Another study[18] has shown that butorphanol has fewer gastrointestinal adverse reactions compared with other opioids, such as sufentanil. In this study, butorphanol combined with propofol was used in ultrasonic bronchoscopy to evaluate its clinical application value from many aspects.

BIS is an index reflecting the functional status of the cerebral cortex and it can effectively monitor the depth of anaesthesia and the consciousness of patients during general anaesthesia, which is conducive to the accurate judgment of the depth of anesthesia[19]. Therefore, BIS was employed in this research to detect the depth of anaesthesia. The results showed that the anaesthesia was within the normal range at all the time points in the three groups, suggesting that the anaesthesia methods were safe and effective in each group. Large fluctuations in the hemodynamic indicators were observed before and after bronchoscopy in a simple anaesthesia group. Compared with those in Groups I and II, the MAP and HR decreased at the time of the bronchoscope entering the larynx but SpO_2 increased in Group III. These results imply that butorphanol increases the stability of the patient's circulatory system and oxygen supply and produces mild stress responses. For elderly patients, it can reduce the high blood pressure and increased HR caused by the operation and the occurrence of adverse cardiovascular events. Yin *et al.*[20] proved that the combination of sufentanil or butorphanol with propofol did not cause significant hemodynamic fluctuations in patients undergoing cystectomy before anaesthesia until the recovery time and the sufentanil group showed a transient decrease in SpO_2 at the beginning of the operation, while there was no significant change at all the time points in butorphanol group. According to the findings of Lin *et al.*[21], compared with dexmedetomidine, butorphanol had more stable hemodynamics and a more controllable depth of anaesthesia during anaesthesia for ultrasonic bronchoscopy.

Lu *et al.*[22] demonstrated that butorphanol combined with propofol in painless gastroscopy can reduce the dosage of propofol and shorten the recovery time. In addition to those consistent with the above research results, the findings of the present study showed that Group III had significantly shorter anaesthesia onset time and bronchoscopy duration than the other 2 groups, showing better anaesthesia efficacy. Li *et al.*[23] studied the postoperative analgesic effect in the elderly and found that the butorphanol group had a significantly better ramsay sedation score than the fentanyl group in case of no significant difference in the postoperative VAS scores of patients and significantly lower incidence rate of nausea and vomiting. Du *et al.*[24] showed that butorphanol had a lower VAS score and fewer patients, who needed additional analgesics in laparoscopic surgery than the fentanyl group. In this study, the VAS, BCS and Ramsay sedation scores were used to evaluate the analgesic and sedative effects of butorphanol under bronchoscope-guided anaesthesia and found that both Group II and Group III had lower VAS scores but higher BCS and Ramsay sedation scores than Group I, indicating that propofol combined with opioids can improve the sedative and analgesic effect from 5 min to 1 hr after bronchoscopy. Besides, the ramsay sedation score in Group III was significantly higher than that in Group II from 5 min to 1 hr after bronchoscopy, probably because sufentanil mainly activates μ-opioid receptors and thus has a stronger analgesic effect but a weaker sedative effect, while butorphanol can activate both κ-opioid receptors and μ-opioid receptors[22], thereby producing more accurate analgesic and analgesic effects[25].

Nausea and vomiting are common complications after surgical anaesthesia, with an incidence rate of about 30%. According to the previous literature[26], nausea is produced through the forebrain, the emetic nerve is located at the tail of after rain, κ-opioid receptors are mainly distributed in the cerebral cortex and μ-opioid receptors are mainly distributed in the midbrain, striatum, thalamus and other areas related to nausea and vomiting. A study[27] has shown that stimulating μ1 opioid receptors will produce analgesic effects while acting on μ2 opioid receptors will cause adverse reactions. Sufentanil may stimulate the μ1 and μ2 opioid receptors at the same time, thereby leading to analgesia and adverse reactions. Butorphanol may reduce the incidence rate of adverse reactions through the dual effects of agonist and antagonist on μ-receptors. The study of Kaur *et al.*[28] showed that compared with sufentanil, butorphanol did not cause vomiting and central excitement, so there were fewer adverse phenomena like nausea and vomiting. Since butorphanol had both agonist/antagonist effects on μ-opioid receptors, there were few adverse reactions such as dizziness, miosis, pruritus, constipation, respiratory depression and drug dependence.

CONCLUSION

In conclusion, butorphanol combined with propofol for induction can shorten the bronchoscopy duration and

recovery time, improve the patient's comfort and produce better anaesthesia, analgesia and sedation effects and fewer postoperative adverse reactions, so it is more suitable for ultrasonic bronchoscopy. Notwithstanding, this study had a small sample size and the precise equivalent dose of anaesthetics needs to be explored by more clinical trials.

SIGNIFICANCE STATEMENT

This study discovers the significant anaesthetic effects of butorphanol combined with propofol on ultrasonic bronchoscopy that can be beneficial for elderly patients. This study will help the researcher to uncover the critical area of anaesthesia for ultrasonic bronchoscopy for the elderly that many researchers were not able to explore. Thus, a new theory on the action mechanism of butorphanol combined with propofol may be arrived at.

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