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Evaluation of Supraglottic Jet Oxygenation and Ventilation in 105 Patients During Bronchoscopy Using the Twinstream® Microprocessor-Controlled Jet Ventilator and the Wei Nasal Jet® Tube

Authors' Contribution:
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Data Collection B
Statistical Analysis C
Data Interpretation D
Manuscript Preparation E
Literature Search F
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Financial support: Dr. Huafeng Wei is the inventor of the Wei Nasal Jet Tube (Wei Nasal Jet or WNJ), which was used to generate SJOV in this study
Conflict of interest: None declared

Background: The Twinstream® ventilator is a microprocessor-controlled electric jet ventilator that allows the simultaneous application of 2 different jet streams, one at low frequency and one at high frequency to result in pulsatile bi-level (p-BLV) mode of ventilation. This study aimed to evaluate supraglottic jet oxygenation and ventilation in 105 patients during bronchoscopy using the Twinstream® microprocessor-controlled jet ventilator and the Wei Nasal Jet® (WNJ) tube.

Material/Methods: Patients were randomly divided into 2 parallel groups (N=50 per group): group W using the WNJ tube and group M using an endoscopic face mask connected to Twinstream® microprocessor-controlled jet ventilator under monitored anesthesia care. Arterial blood gas was examined and recorded 15 minutes after the initiation of procedure. The demographic and clinical characteristics, procedure duration, doses of anesthetics, and adverse events in the 2 groups were also recorded.

Results: The arterial partial pressure of carbon dioxide ($PaCO_2$) (P=0.006) and lactic acid (P=0.001) were significantly lower, while pH (P=0.024) was significantly higher than in the group M. Pearson analysis showed that $PaCO_2$ was significantly correlated with ventilation tools (P=0.006) and procedure duration (P=0.003). Multiple linear regression analysis showed that ventilation tools and procedure duration were both independent influencing factors (P=0.006, P=0.002).

Conclusions: Supraglottic jet oxygenation and ventilation using the WNJ tube can reduce $PaCO_2$ and had advantages in enhancing oxygenation and ventilation function in patients during bronchoscopy intervention therapy under monitored anesthesia care.

Keywords: **Airway Management • High-Frequency Jet Ventilation • Hypoxia**

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Background

The incidence of lung diseases and tumors has been increasing constantly [1]. Bronchoscopy intervention technology has remarkable advantages in the diagnosis and treatment of pulmonary airway diseases, which are often treated under monitored anesthesia care [2,3]. Studies have shown that more than half patients undergoing bronchoscopy intervention experienced intraoperative hypoxemia in the absence of adequate oxygen administration [4]. Another study found that the incidence of intraoperative hypoxemia was about 40% during bronchoscopy intervention therapy under monitored anesthesia care [5].

Ventilation strategies are mainly divided into supraglottic airway (SGA) and subglottic tools. SGA is a relatively non-traumatic ventilation method that can maintain airway oxygenation during bronchoscopy intervention therapy. The advantages of using SGA include easier placement, less need of anesthetic drugs, and lower incidence of laryngeal and vocal cord injuries [6]. Laryngeal mask airway (LMA) and I-gel are commonly used for this purpose [7,8]. However, the insertion of LMA requires a deeper depth of anesthesia and causes more damage to the larynx. Due to its comfort and simplicity of wearing, endoscopic face masks are more widely used in clinical practice. The Wei Nasal Jet® (WNJ) tube is a newly invented 2-wall nasal airway for supraglottic jet oxygenation and ventilation (SJOV) and end-tidal partial pressure of carbon dioxide (CO_2) monitoring [9-12].

Its inner diameter is 5.0 mm, outer diameter is 7.5 mm, and length is 18 cm. Although the WNJ tube has been used during bronchoscopy [12], there are no studies comparing the effects of WNJ tube versus endoscopic face mask on pulmonary oxygenation and ventilation function during bronchoscopy intervention under monitored anesthesia care. SJOV is a minimally invasive technique of jet ventilation with the jet nozzle above the vocal cords and delivering high concentrations of oxygen with jet ventilation driving pressure [10]. It aims at improving oxygenation in patients with respiratory depression and is widely used in cases with difficult airways [6,10-17].

The WNJ tube was proposed to be a better choice than endoscopic face masks for patients during bronchoscopy intervention therapy under monitored anesthesia care. This clinical trial aimed to examine SJOV using the WNJ tube on pulmonary oxygenation and ventilation function during bronchoscopy intervention therapy compared to SGA devices with endoscopic face mask.

Material and Methods

Ethics Approval

The study received ethics approval of the senior academic committee of Emergency General Hospital, Beijing, China (K21-39) on 29/11/2021. All patients agreed to participate in the study and signed informed consent before surgery. This study was registered and approved by the Chinese Clinical Trial Registry on 06/12/2021. The registration number of this study is: ChiCTR2100054001 (Chinese Clinical Trial Registry).

Study Population

Patients were selected by the Center of Bronchoscopy Intervention, Emergency General Hospital, to undergo bronchoscopy intervention from December 2021 to January 2022. Inclusion criteria were as follows: (1) Underwent electronic flexible bronchoscope; (2) Duration of operation, between 20 and 60 minutes; (3) Age, 18-80 years; (4) ASA classification I-III. Exclusion criteria were as follows: (1) Diagnosed with cardiac respiratory failure and coma; (2) T-tube, endotracheal intubation, and tracheotomy, or SpO_2 <90% in ambient air before the surgery; (3) History of mental and neurological disorders, sedative or hypnotic drugs and alcohol abuse; (4) History of nasal disease and surgery; (5) Change the methods of anesthesia during the operation; (6) Intraoperative massive hemorrhage; (7) History of nasopharyngeal tumor and surgery.

In accordance with different ventilation tools, the eligible patients were randomized in a 1: 1 ratio into 2 parallel groups by a physician blinded to the study. The 2 groups were the Wei Nasal Jet® tube (Well Lead Medical Ltd., Guangzhou, China) group (group W) and endoscopic face mask group (group M). Preoperatively, the anesthesiologist opened an envelope containing a group allocation number to ensure study blinding. A data investigator collected and recorded all perioperative data. The statistician and investigator were independent and blinded to the treatment.

All bronchoscopy intervention therapy procedures were performed by experienced endoscopists using electronic flexible bronchoscopes (Pentax, Japan).

Anesthetic Settings and Maintenance

Electrocardiogram (ECG), pulse oximetry (SpO_2), and blood pressure monitoring were performed upon entrance to the operating room. Lidocaine (1%, 10 ml) was administered via the spray-as-you-go technique before bronchoscopy intervention procedure. Oxygen was inhaled by endoscopic face mask during anesthesia induction. One ml remifentanil (40 $\mu g \cdot ml^{-1}$) was intravenously dripped with an interval of 1 min, and total

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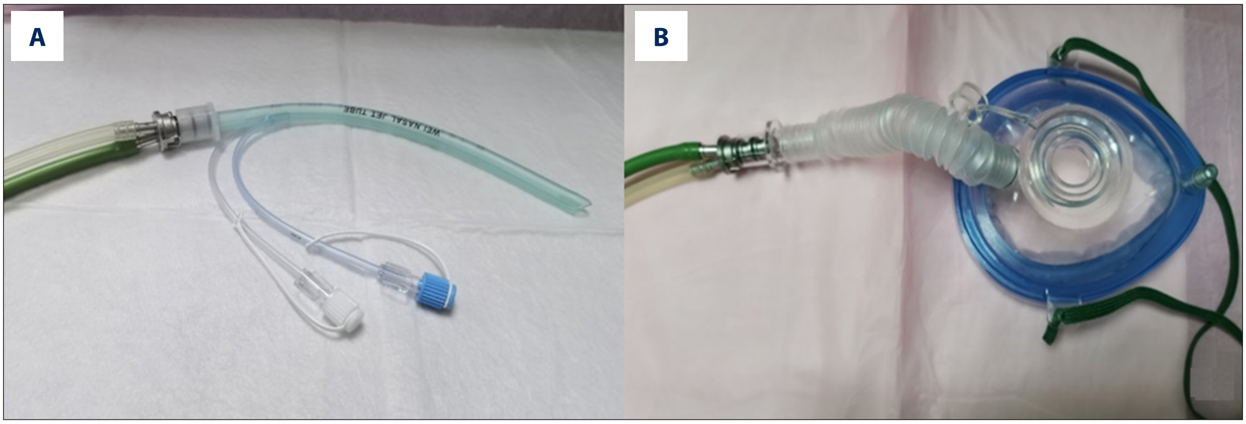

Figure 1. Connection of Wei Nasal Jet® tube (**A**) and endoscopic face mask (**B**) to the Twinstream® jet ventilator.

bolus dose of remifentanil was 1 μg·kg^{-1}. Propofol (1 mg·kg^{-1}) was injected 2 min after remifentanil injection during anesthesia induction.

Before placing WNJ, the nasal cavity was cleaned and lubricated, and 5 ml lidocaine ointment was applied to the outer wall of the WNJ tube. After sedation, the WNJ tube was inserted into the unobstructed nostril of patients. If the first placement failed, a second attempt could be made through the patient's contralateral nasal cavity. If the second attempt failed again, the placement would be abandoned and an endoscopic face mask would be used instead. If the patient had nasal cavity bleeding, the insertion of the WNJ tube would be stopped. The nasal bleeding would be observed by flexible electronic bronchoscopy, and the corresponding hemostatic measures would be given. The position of the WNJ tube was confirmed by the endoscopists through an electronic flexible bronchoscope. Then, we connected the WNJ to a Twinstream® ventilator (Carl Reiner GMBH, Vienna, Austria). The ventilator parameters were set as fractional inspired oxygen (FiO_2) of 1.0, a driving pressure (DP) of 14.5 psi, respiratory rate (RR) of 15 bpm, and I/E ratio of 1: 1.5.

The patients of group M were ventilated by endoscopic face mask with a Twinstream® ventilator. The parameters were the same as for group W. The connection of the WNJ (A) and endoscopic face mask (B) to the Twinstream® ventilator are shown in **Figure 1**.

Continuous infusion of remifentanil (0.10~0.15 μg·kg^{-1}·min^{-1}) and propofol (30~50 μg·kg^{-1}·min^{-1}) by microinjection pumps was administered and stopped at the end of the operation. The patients of group W and group M breathed spontaneously during the bronchoscopy intervention, maintaining a Ramsey sedation scale (RSS) score of 4~5. When the SpO_2 value was <95%, the anesthesiologists increased the driving pressure by 7.25 psi and RR by 5 bpm, and when the SpO_2 value was <90%, the anesthesiologists rescued with mask-bag ventilation. The fluctuation of the patient's mean arterial blood pressure (MAP) was controlled at a variation within 20% of the baseline. If the fluctuation of MAP was more than 20%, the depth of anesthesia was adjusted or a vasopressor was given.

Data Collection

Demographic Data Included: Age, Body Mass Index (BMI), and Gender

Clinical data included: American Society of Anesthesiologists (ASA) classification, comorbidities, type of pulmonary disease, pathology, lesion location, degree of the airway stenosis, and procedure duration. The location of airway lesions was divided into 4 types: 1) main airway, 2) left or right main bronchial, 3) more than 2 lesion sites of airway, and 4) no airway lesion or distal bronchial. The degree of airway stenosis was graded to 4 levels: 1 for 0~49%, 2 for 50~74%, 3 for 75~89%, and 4 for above 90%.

Arterial blood gas analyses (arterial partial oxygen pressure [PaO_2] and arterial partial pressure of carbon dioxide [$PaCO_2$], pH, lactic acid) and glucose blood level were examined and recorded 15 minutes after initiation of the procedure.

Adverse events included: the incidence of intraoperative hypoxemia (SpO_2 <90%), intraoperative severe hypercapnia ($PaCO_2$ ≥80 mmHg), postoperative hypoxemia (SpO_2 <90%), chemosis, and delayed recovery and transfer to the intensive care unit (ICU). The number of anesthetic doses was also recorded.

The primary aim was to evaluate the difference in PaO_2 and $PaCO_2$ between the 2 groups and its influencing factors. The secondary aims were to evaluate the differences in intraoperative glucose blood level, the incidence of adverse events, and number of anesthetic doses between the 2 groups.

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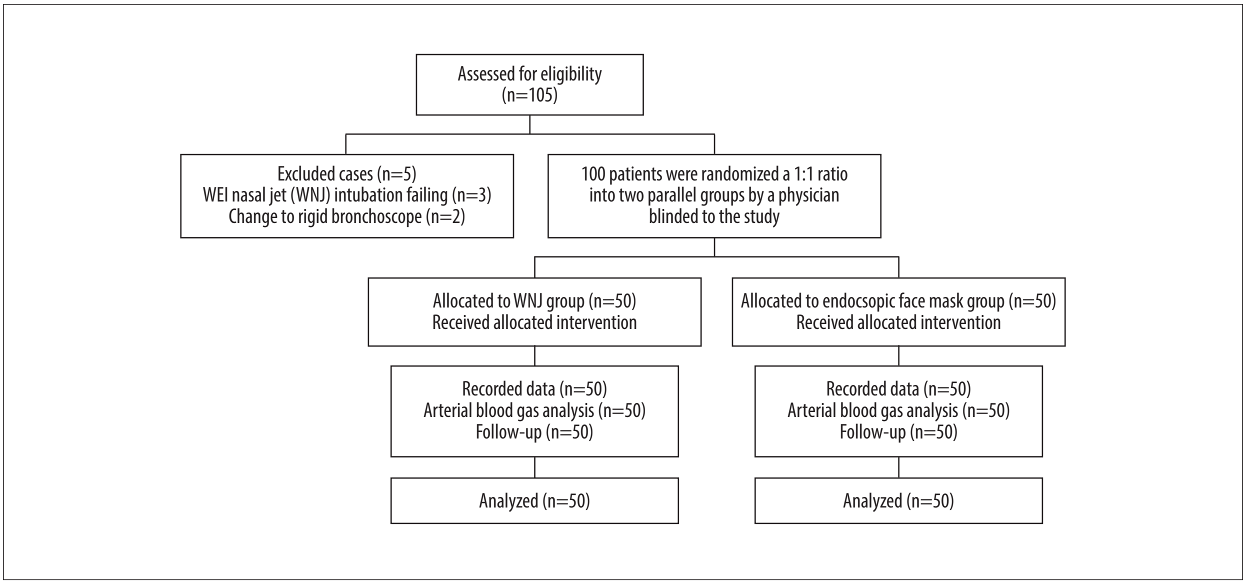

Figure 2. Flow diagram.

Statistical Analysis

In a pilot trial of 10 patients, $PaCO_2$ was 54.5±8.62 mmHg and 62.4±13.19 mmHg. The sample size was estimated by the formula $n=(\mu_\alpha \pm \mu_\beta)^2(1+1/k)\ \sigma^2/\delta^2$ with a standard deviation of 0.8, and bilaterally equal to 0.05, or even 0.2 (power=0.8). This study thus planned to enroll 34 patients in each group, following sample size power analysis.

SPSS 20.0 software was used for data collation and statistical analysis. The Shapiro-Wilk method (W test) of SPSS was used to test normality of the data. The continuous data were expressed as mean±SD, and the count data were presented as the number and percentage. The chi-square test was used to compare the count data between the 2 groups. Univariate analysis of variance was used for overall comparison between the 2 groups, and least significance difference was used for multiple comparison between groups. Pearson analysis was used to investigate the correlation between blood gas indicators of PaO_2 and $PaCO_2$ and the clinical indicators of patients. Multiple linear regression analysis was used to explore the independent influencing factors of $PaCO_2$. $P<0.05$ was considered statistically significant.

Results

A total of 105 patients were enrolled. Three patients in group W were excluded because of failure of WNJ insertion and 2 patients in group M were excluded because of changing to a rigid bronchoscope under general anesthesia. All remaining patients tolerated the bronchoscopy intervention therapy well (**Figure 2**).

The demographic and clinical characteristics of patients are represented in **Table 1**. There were no significant differences between 2 groups in terms of age, BMI, gender, ASA classification, comorbidities, type of pulmonary disease, pathological type, lesion location, the degree of the airway stenosis, and the duration of procedure (P=0.808, P=0.206, P=0.915, P=0.191, P=0.234, P=0.056, P=0.357, P=0.495, P=0.773, P=0.148, P=0.242, P=1.000, P=0.088, P=0.207, P=0.755, P=0.452, respectively).

The results of arterial blood gas analysis showed that there was no significant difference in PaO_2 and glucose between 2 groups (P=0.433, P=0.256). The $PaCO_2$ (P=0.006) and lactic acid (P=0.001) levels were significantly lower, while pH (P=0.024) was significantly higher than in group M. Moreover, there were no significant differences in total doses of propofol and remifentanil. The incidence of adverse events did not differ significantly between the groups. Details are shown in **Table 2**.

Perioperative factors associated with $PaCO_2$ were assessed via Pearson analysis. Age, BMI, ASA classification, chronic obstructive pulmonary disease, tracheal fistula, lobectomy, pulmonary tuberculosis, pulmonary bulla, lesion location, and degree of stenosis were not statistical correlated with increased $PaCO_2$. Increased $PaCO_2$ was significantly correlated with ventilation tools used (P=0.006) and procedure duration (P=0.003). The correlation coefficient between $PaCO_2$ and ventilation tools was 0.276, and the correlation coefficient between $PaCO_2$ and procedure duration was 0.293. The $PaCO_2$ significantly decreased with the use of a WNJ tube compared with endoscopic masks, but PaO_2 did not vary. $PaCO_2$ level also rose with longer procedure duration. Details are shown in **Figure 3**.

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Table 1. Comparison of demographic and clinical patient characteristics between the 2 groups.

Characteristic	Group W (n=50)	Group M (n=50)	*P* value
Age, mean±SD, years	50.96±10.76	51.48±10.54	0.808
Body mass index, mean±SD (%)	23.27±4.51	22.29±3.12	0.206
Male, n (%)	33 (66)	32 (64)	0.915
ASA Classification			0.191
Class I, n (%)	0 (0)	1 (2)	
Class II, n (%)	23 (46)	30 (60)	
Class III, n (%)	27 (54)	19 (38)	
Comorbidities			
Cardiovascular history, n (%)	9 (18)	4 (8)	0.234
Hypertension disease, n (%)	5 (10)	0 (0)	0.056
Diabetes mellitus, n (%)	8 (16)	4 (8)	0.357
Pulmonary Comorbidities			
Chronic pulmonary disease, n (%)	2 (4)	0 (0)	0.495
Tracheal esophageal fistula, n (%)	1 (2)	1 (2)	0.773
Lobectomy, n (%)	10 (20)	4 (8)	0.148
Pulmonary tuberculosis, n (%)	0 (0)	3 (6)	0.242
Pulmonary bulla, n (%)	1 (2)	0 (0)	1.000
Pathology			0.088
Non-tumor, n (%)	12 (24)	21 (42)	
Tumor, n (%)	38 (76)	29 (58)	
Lesion location			0.207
Main airway, n (%)	29 (58)	22 (44)	
Left or right main bronchus, n (%)	16 (32)	15 (30)	
Mixed airway, n (%)	1 (2)	3 (6)	
No lesion, n (%)	4 (8)	10 (20)	
Degree of stenosis			0.755
0-49%, n (%)	27 (54)	23 (46)	
50-74%, n (%)	9 (18)	10 (20)	
75-89%, n (%)	4 (8)	7 (14)	
≥90%, n (%)	10 (20)	10 (20)	
Procedure duration (min)	27.60±12.63	29.42±11.44	0.452

Data are expressed as mean±standard deviation or as numbers and percentages. Group W – Wei nasal jet tube group; Group M – endoscopic face mask group; ASA – American society of Anesthesiologists.

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Table 2. Arterial blood gas analysis, anesthetic doses, and adverse events between the 2 groups.

Patients' values	Group W (n=50)	Group M (n=50)	*P* value
Arterial blood gas			
PaO_2 (mmHg)	239.10±104.65	223.82±88.69	0.433
$PaCO_2$ (mmHg)	56.36±11.29	63.10±12.44*	**0.006**
Pondus Hydrogenii	7.33±0.61	7.29±0.06*	**0.001**
Glucose (mmol·l^{-1})	6.62±1.82	7.43±4.70	0.256
Lactic acid (mmol·l^{-1})	0.95±0.46	1.32±1.03*	**0.024**
Anesthetic doses			
Propofol (ml)	10.08±3.14	10.84±6.35	0.450
Remifentanil (ml)	5.41±2.43	5.24±2.99	0.759
Adverse events			
Intraoperation hypoxemia, n (%)	3 (6.0)	7 (14.0)	0.318
Intraoperation severe hypercapnia, n (%)	1 (2.0)	5 (10.0)	0.204
Post-operation hypoxemia, n (%)	1 (2.0)	2 (4.0)	1.000
Chemosis, n (%)	0 (0.0)	1 (2.0)	1.000
Delayed recovery, n (%)	0 (0.0)	1 (2.0)	1.000
Transfer to ICU, n (%)	1 (2.0)	2 (4.0)	1.000

Data are expressed as mean±standard deviation or as numbers and percentages. * Statistically significant compared with group W, $P<0.05$. Group W – Wei nasal jet tube group; Group M – endoscopic face mask group; Propofol: 10 mg·ml^{-1}; Remifentanil: 40 μg·ml^{-1}. PaO_2 – arterial partial oxygen pressure; $PaCO_2$ – arterial partial pressure of carbon dioxide; ICU – Intensive Care Unit. Intra-operation severe hypercapnia: Intra-operation $PaCO_2$ ≥80 mmHg.

Multiple linear regression was performed to analyze the predictive value of ventilation tools and procedure duration for $PaCO_2$. The results showed that ventilation tools and procedure duration were both independent influencing factors (P=0.006, P=0.002). The linear regression equation for $PaCO_2$ and procedure duration was {y=51.13+0.304*x}, in which y=$PaCO_2$ and x was procedure duration, with a fitness of model R^2=0.093. The linear regression equation for $PaCO_2$ and ventilation tool was {y=56.36+6.740*x}, in which y=$PaCO_2$ and x was ventilation tool, with a fitness of model R^2=0.076. Details are shown in **Table 3**.

Discussion

Monitored anesthesia care is increasingly used during bronchoscopy intervention therapy. It is preferred because it is associated with reduced incidence of intraoperative cough and it alleviates patient discomfort [3], and it allows rapid anesthesia emergence and recovery [2]. Proper respiration support during pulmonary procedures is a key factor. However, frequent mandatory sharing of the airway with the endoscopist during bronchoscopy intervention therapy makes it difficult to maintain oxygenation in patients under monitored anesthesia care.

Hypoxemia is the most common and severe intraoperative complication, accounting for 25% of anesthesia-related deaths [16]. ASA difficult airway management algorithm guidelines suggest that the use of I-gel can be replaced with some new supraglottic airway devices [18]. The advantages of WNJ use include ease of use, fewer complications, and the potential to increase the functional residual capacity (FRC) of the lungs. WNJ has become a commonly used ventilation tool for difficult airway management, especially for patients with poor cardiopulmonary function [9]. Jet ventilation is a technique used to maintain oxygenation and ventilation. SJOV via WNJ keeps ventilation systems open with few complications [12] and can assist oxygenation and ventilation during spontaneous breathing and apnea [16], as well as elective or emergent difficult airway management [19] for up to 45 minutes [15].

Feng et al demonstrated that SJOV via WNJ can effectively maintain adequate oxygenation and improve safety in patients with BMI over 30 undergoing hysteroscopies [14]. It also maintains adequate oxygenation during multiple and prolonged intubations in urgent difficult airway management [11,14]. Behrens suggested that SGA maintains oxygenation effectively, reduces anesthetic doses needed, and decreases risk for pulmonary

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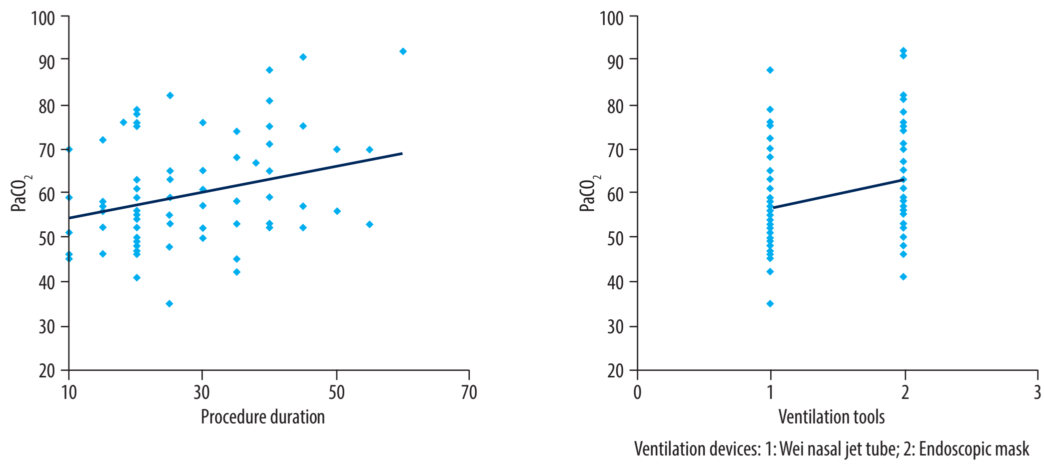

Figure 3. Pearson analysis of arterial partial pressure of carbon dioxide ($PaCO_2$) with related factors.

Table 3. Multiple linear regression analysis of blood gas $PaCO_2$ related factors.

Independent variable	Dependent variable	Correlation coefficient	β-coefficient	R^2	*P* value
Ventilation tools	$PaCO_2$	0.276	6.740	0.076	**0.006**

Constant=56.36.
Ventilation tools used were WEI nasal jet tube and endoscopic face mask.

Independent variable	Dependent variable	Correlation coefficient	β-coefficient	R^2	*P* value
Procedure duration	$PaCO_2$	0.293	0.304	0.093	**0.002**

Constant=51.13.
$PaCO_2$ – arterial partial pressure of carbon dioxide.

complications [6]. Qin et al applied SJOV in patients receiving upper gastrointestinal endoscopy under monitored anesthesia care and demonstrated that SJOV had a good risk-benefit ratio and improved patient safety [10]. In another study, SJOV via WNJ was effective in providing airway support and improving intraoperative oxygenation [20].

Airway intervention surgery is a complex and high-risk procedure. Hypoxemia can occur at any time during airway procedures under sedation. Making correct choices about anesthesia, ventilation tools, ventilation methods, and strategies are critical to minimizing hypoxia [21,22]. Various techniques had been applied to ensure intraoperative oxygenation and ventilation of patients [23]. A balance among adequate oxygenation, depth of anesthesia, and patient airway safety is the key to anesthesia management for bronchoscopy intervention therapy procedures. In previous studies, SJOV via WNJ tube was found to reduce the incidence of intraoperative hypoxemia compared with nasal oxygen [10,12] and face mask oxygen [14]. A previous study found that use of an endoscopic face mask combined with SJOV improved oxygenation better than mask combined with high-flow oxygen [13]. Therefore, this study compared the oxygenation and ventilation function in SJOV via WNJ tube and endoscopic face mask during bronchoscopy intervention therapy under monitored anesthesia care.

The results showed that there was no significant difference in PaO_2 and incidence of hypoxemia in patients with WNJ tube and endoscopic face mask, although the incidence of hypoxemia with endoscopic face mask was relatively higher. However, the $PaCO_2$ of patients with WNJ tube was significantly lower than that using an endoscopic face mask. Pearson and multiple liner regression analysis both showed that $PaCO_2$ was significantly correlated with ventilation tools. Additionally, the lactic acid levels of patients with WNJ tube were significantly lower than that of patients with endoscopic face mask, and pH was significantly higher than that of patients with endoscopic face mask.

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Many studies have focused on oxygen supply rather than CO_2 exhalation. After the administration of anesthetic drugs, the tendency for relaxation and collapse in upper respiratory tract tissue and muscle are inevitable [24], and the pharynx is the only segment of the upper airway that is not bounded by bony structures [25]. Glossocoma can cause significant upper airway obstruction and insufficient ventilation [26]. When ventilation is insufficient, SpO_2 may be maintained in the normal range, but expiratory function may be impaired, resulting in hypercapnia and cardiovascular complications [27]. Lactic acid is the product of anerobic metabolism in the body and is considered as an indicator of tissue hypoxia [28] and a predictor of prognosis in critically ill patients. Increased blood lactic acid may occur when respiratory failure is accompanied with hypoxia, but most patients with respiratory failure have a normal or only mild increased blood lactic acid level. When severe respiratory failure occurs, it can also be accompanied by a significant increase in lactic acid, which may be caused by insufficient ventilation and hypoxia in the early stage. In this study, SJOV via WNJ delivered a high concentration of oxygen from the nasal cavity to the glottis, creating an artificial airway directly to the glottis and avoiding upper airway obstruction, thus improving ventilation. Although no difference in PaO_2 was found between the WNJ and endoscopic mask groups, the slight increase in lactic acid also indicated a difference in ventilation capacity.

$PaCO_2$ levels of patients increased with longer procedure duration and obstructive upper airway, leading to hypercapnia. Hypercapnia during bronchoscopy intervention therapy has long been a concern, as a sharp increase in CO_2 levels can increase intracranial pressure and reduce cerebral perfusion, leading to cerebral ischemia [29,30]. Cheng et al proposed that hypercapnia ($PaCO_2$ ≤100 mmHg) does not cause postoperative delirium and it improved postoperative cognitive function of patients, but it has an adverse effect on cognitive function when it is above 100 mmHg [31-33]. Jet ventilation at high frequency can impair CO_2 elimination. Cheng and colleagues used an endoscopic mask in combination with high-frequency jet ventilation (HFJV) to supply oxygen for patients undergoing bronchoscopy intervention therapy and found that HFJV did not aggravate hypercapnia compared with normal frequency jet ventilation and conventional oxygenation [13].

Accordingly, the present study shows that the use of SJOV via a WNJ tube can improve ventilation function during bronchoscopy intervention therapy. Appropriate ventilation tools can meet the needs of surgery and improve intraoperative pulmonary function.

The present study has some limitations showed. First, we did not use bispectral index and neuromonitoring to determine the depth of sedation. RSS can be influenced by the concentration, dose, and rate of administration of anesthetics. BIS monitoring could potentially eliminate it. Second, no evaluation or comparison of postoperative pharyngeal conditions between groups was conducted. Thirdly, the Mallampati score was not used, which may affect ventilation function after anesthesia.

Conclusions

In summary, SJOV via WNJ tube and endoscopic face mask can both maintain oxygenation during bronchoscopy intervention therapy under monitored anesthesia care. SJOV via WNJ tube can reduce $PaCO_2$ and lactic acid levels by preventing upper respiratory tract collapse, enhancing pulmonary ventilation function during bronchoscopy intervention therapy under monitored anesthesia care.

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Declaration of Figures' Authenticity

All figures submitted have been created by the authors, who confirm that the images are original with no duplication and have not been previously published in whole or in part.

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