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Application of visual laryngeal mask combined with bronchial occluder in thoracoscopic partial lobectomy

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【**Abstract**】**Objective:** To explore the feasibility and advantages of visual laryngeal mask combined with bronchial occluder in thoracoscopic partial lobectomy. **Methods:**Eighty patients who underwent thoracoscopi c partial lobectomy under general anesthesia from Dec. 2021 to May 2022 were randomly divided into visual l aryngeal mask combined with bronchial occluder group (SafeLM group) and double-lumen bronchial catheteriz ation group (control group) with 40 cases in each group. The incidence of postoperative intuba- tion adverse events such as pharyngalgia and hoarseness were analyzed and compared between the two groups. Mean arteri al pressure , heart rate were recorded before anesthesia induction (T_0) ,after induction (T_1) ,immediately aft er insertion of laryngeal mask or endo- tracheal tube (T_2) ,2 min (T_3) after insertion of laryngeal mask or endotracheal tube ,immediately after removal of laryngeal mask or endotracheal tube (T_4) ,and 2 min (T_5) after removal of laryngeal mask or endotracheal tube. The airway plateau pressures (P_1 ,P_2 , P_3) and oxyge n saturation were recorded after 5 min of double-lung ventilation (T_6) ,5 min of single-lung ventilation (T_7) ,and 5 min after recovery of double-lung ventilation after surgery (T_8) . The intubation positioning time ,op eration time ,one-lung ventilation time , anesthesia time ,hospital stay , 10-min one-lung ventilation lung colla pse ,the incidence of catheter displacement ,the Aldrete recovery score ,15-item quality of recovery score bef ore and 1 day after surgery ,and postoperative satisfaction were compared between the two groups. **Results**:O ne patient was excluded in SafeLM groupand one in control group , and 78 patients were included. The inci - dences of sore throat and hoarseness in the SafeLM groupwere 5. 1% and 2. 6% ,respectively ,which were s ignificantly lower than those in the control group (43. 6% and 25. 6%) ,and the difference was statistically signific ant ($P<0.05$). Compared with control group,SafeLM grouphad lower mean arterial pressures at T_2 ,T_4 ,T_5 ($P<0.05$) , lo wer airway platform pressure (P1 ,P2 ,P3) at T6 , T7 ,T8 ($P<0.05$) ,higher QoR-15 score on the 1st day after o peration ($P<0.05$) ,shorter hospital stay and higher postoperative satisfaction ($P<0.05$) . There was no significant difference in other observed indexes ($P>0.05$) . **Conclusions:**Visual laryngeal mask com- bined with bronchial occluder can meet the requirements of one-lung ventilation in thoracoscopic partial lobectomy , and can red uce adverse reactions related to intubation ,reduce perioperative circulatory fluctuations ,shorten hospital stay,impr ove patients 'satisfaction , and promote the rapid recovery of patients.

【 Key words】Visual laryngeal mask;Bronchial occluder; One-lung ventilation; Pneumonectomy; Thoracoscopy

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Thoracoscopic surgery has the advantages of minimal trau ma, wide surgical field, and quick postoperative recovery, a nd has been widely applied in clinical practice [1]. The lung isolation technique has become an essential condition for th oracoscopic surgery. Currently, double-lumen endotracheal intubation is one of the most commonly used methods in cli nical work for lung isolation techniques [2]. However, the t raditional double-lumen endotracheal tube is hard in materi al, has a relatively thick outer diameter, and a smaller inner diameter. During single-lung ventilation, the airway resista nce is high, which often causes varying degrees of damage to the airway and brings a series of intubation-related adver se reactions. In recent years, single-lumen endotracheal tub es combined with bronchial occluders have been widely us ed in thoracoscopic single-lung ventilation surgeries. Altho ugh they have reduced the stimulation to the throat area to a certain extent, there are still large fluctuations in hemodyna mics and pharyngeal pain and hoarseness as intubation risk s [3-4]. The laryngeal mask has the characteristics of minim al trauma and mild stimulation. Hou Tao et al. applied the I -gel laryngeal mask combined with the Coopdech bronchial occluder in thoracic surgeries and achieved good clinical re sults. To reduce intubation-related risks, improve postopera tive comfort of patients, and promote rapid recovery, this st udy used a visual laryngeal mask combined with a bronchia l occluder in thoracoscopic partial lung resection surgeries t o explore its feasibility and advantages, with the aim of pro viding a reference for clinical practice.

1 Materials and Methods

1.1 Clinical Data This study was approved by the hospital ethics committee and obtained the informed consent of the patients and their families. Eighty patients of both sexes, ag ed 18-65 years, of American Society of Anesthesiologists p -hysical status i-ii, with BMI &lt, who underwent thoracosc opic partial pneumonectomy in our hospital from Decembe r 2021 to May 2022, were selected. 30 kg/m2. Inclusion crit eria: Partial wedge resection of the lung and small segment resection of the lung are planned, cardiac function is grade I to II, and no obvious abnormalities are found in liver, kidn ey and lung functions. Exclusion criteria: preoperative cogn itive dysfunction, difficult airway, airway reactive disease, abnormal tracheal anatomy (right upper lobe opening highe r than tracheal carina), accumulated lesions in the main bro nchus, reflux aspiration and other risk factors, and the estim ated amount of complex blood loss or more than 2 hours of surgery.

1. 2 Grouping The patients included in the study were rand omly divided into two groups according to the random num ber table method: the laryngeal mask combined bronchial o ccluder group (experimental group) and the double-lumen b ronchial catheter group (control group), with 40 cases in ea ch group. There was no statistically significant difference in gender, age, and left-right lung surgery between the two gro ups ($P > 0.05$). Experimental group: Suitable laryngeal mas k type was selected according to the weight of patients. The lubricate visual laryngeal mask was inserted down the midli ne of the patient's oral cavity with a pen type. Obvious resis tance could be felt after the laryngeal mask was in place. Af ter the appropriate amount of air was injected, the whole gl ottis could be seen through the laryngoscope, indicating that the laryngeal mask was in good position [5]. The bronchial blocker was placed under the monitoring of the visual adjus table video laryngoscope, and then fixed by the fiberoptic b ronchoscope. Control group: the appropriate catheter model was selected according to the inner diameter of the trachea measured by preoperative chest CT. The double-lumen bro nchial tube was inserted using a common visual laryngosc

ope, and then fixed after positioning with a fiberoptic bronchoscope. The insertion of laryngeal masks, the placement of bronchial occluders and tracheal intubation were all performed by a skilled attending physician.

1. 3 Anesthesia method Routine preoperative fasting and fluid restriction for 8 hours. After entering the room, peripheral veins were opened, oxygen was inhaled, electrocardiogram, blood oxygen saturation, heart rate, bispectin index of EEG, and blood pressure were routinely monitored. After local infiltration with 1% lidocaine, radial artery puncture and catheterization were performed to measure invasive arterial blood pressure. Before induction, 0.5 μg/kg of dexmedetomidine hydrochloride (administered within 15 minutes) is given. Anesthesia induction: Intravenous injection of sufentanil 0.5 μg/kg, propofol 1-2 mg/kg, and cisatracurium benzenesulfonate 0.15 mg/kg. Anesthesia was maintained by intravenous infusion of remifentanil 0.1-0.2 μg/ (kg ·min), continuous inhalation of desflurane, intermittent addition of cisatracurium besylate, and bispectral index was maintained at 40-60. Mechanical ventilation parameters: synchronized pressure-controlled volume-assured ventilation mode, double-lung ventilation tidal volume 8 mL/kg, respiratory rate 11 - 13 breaths/min; The tidal volume of one-lung ventilation is 6 mL/kg, the respiratory rate is 14-18 times per minute, and the positive end-expiratory pressure is 5 CMH_2O, maintaining the end-expiratory carbon dioxide at 35-45 mmHg and the airway pressure at 12-30 CMH_2O. All groups adopted a unified analgesic protocol after the operation.

1.4 Observation Indicators: General conditions of the two groups of patients: gender, age, ASA classification, surgical side, BMI. The after removal of LMA or tracheal tubepatients in the two groups were recorded before induction (T0), after induction (T1), immediately after insertion of LMA or tracheal tube (T2), 2 min after insertion of LMA or tracheal tube (T3), immediately (T4), and 2 min after removal of LMA or tracheal tube (T5). The mean arterial pressure (MAP), heart rate (HR), and airway plateau pressure (P1) after 5 min of two-lung ventilation (T6), 5 min of one-lung ventilation (T7), and 5 min of recovery of two-lung ventilation (T8) were recorded , P2 and P3). Compare the intubation positioning time, single-lung ventilation time, operation time, anesthesia time, hospital stay, intraoperative catheter displacement situation, and the incidence of intubation-related adverse events (hoarseness, throat pain, choking, dysphagia) in the two groups. The lung collapse score (the effect of lung collapse was scored by surgeons according to the operation field, with 0 points for complete expansion and 10 points for complete collapse) and the modified Aldrete recovery score (including 5 aspects of activity, respiration, blood pressure, consciousness and oxygenation, with a total of 10 points) were recorded at 10 minutes of one-lung ventilation , the higher the score, the more complete the recovery), the 15-item quality of recovery 1 day before surgery and 1 day after surgery recovery,QoR-15) score (including physical comfort, social, psychological, emotional, pain and other 15 indicators, a total of 150 points, the higher the score is, the better the quality of recovery), postoperative patient satisfaction score (1 point is very dissatisfied,5 points are very satisfied. The higher the score, the higher the patient's satisfaction.

1.5 Statistical processing Data analysis was conducted using SPSS 26.0 software. Measurement data with normal distribution were represented as mean and standard deviation, and comparison between groups was analyzed using the independent sample t test. Measurement data with non-normal distribution were expressed as median and quartile, and comparison between groups was analyzed by nonparametric test.

Counting data were expressed as the number of cases, and the $\chi 2$ test was used for comparison between groups. A P value less than 0.05 indicated statistically significant differences.

2 Results

This study aimed to include 80 cases, but 2 cases were excluded. In this study, 80 cases were included and 2 cases were excluded, including 1 case in the control group. Due to the narrow glottis and high position of the patient, single-lumen bronchial tube combined with bronchial occluder was used after 3 failed attempts of double-lumen bronchial intubation. In the experimental group, there was 1 case with poor ventilation after the placement of the visual laryngeal mask. Even after adjustment, the ventilation condition still could not be improved. Immediate remedial measures were taken, and a single-lumen bronchial catheter of the appropriate model was inserted into the ventilation lumen of the visual laryngeal mask to meet the need for one-lung ventilation during the surgery.

2.1 General situation There were no statistically significant differences in gender, age, BMI, ASA classification, surgical side, intubation positioning time, single-lung ventilation duration, anesthesia and surgery time between the two groups (P > 0.05). However, the hospitalization time of the SafeLM group was shorter than that of the control group (P < 0.05), and the difference was statistically significant. See Table 1 and Table 2.

2.2 Lung collapse situation There was no statistically significant difference in the lung collapse effect at 10 minutes of single-lung ventilation between the two groups (P > 0.05). See Table 3.

2.3 Recovery quality and postoperative satisfaction Compared with the control group, the QoR-15 score on the first day after surgery in the SafeLM group was higher, and the patient satisfaction was higher (P < 0.05), and the difference was statistically significant in the table3.

2.4 Hemodynamic indicators: Compared with the control group, the heart rate of the SafeLM group was slower at T2 and T4, and the mean arterial pressure was lower at T2, T4, and T5, with statistically significant differences (P < 0.05). See Table 4 and Table 5.

2.5 Respiratory Dynamic Indicators At T6, T7, and T8, there was no statistically significant difference in oxygenation indicators between the two groups. However, the airway plateau pressures P1, P2, and P3 of the SafeLM groupwere lower than those of the control group, and the differences were statistically significant (P < 0.05). See Table 6 and Table 7.

2.6 Incidence of Insertion-related Adverse Events The incidence of sore throat and hoarseness in the SafeLM groupwas lower than that in the control group, and the difference was statistically significant (P < 0.05). There was no statistically significant difference in the incidence of choking cough, dysphagia, bronchial occluder or double-lumen bronchial catheter displacement between the two groups. See Table 8.

Table 1 Comparison of general conditions between the two groups (x±s)

Group	Site(n)		sex(n)		ASA Grade(n)		year	BMI
	Left	right	Male	Female	I	II		(kg/m^2)
SafeLM Group	17	22	11	28	4	35	52.13±8.25	24.79±3.58
Control Group	15	24	10	29	5	34	52.82±10.93	24.64±3.17
t/χ^2	0.212		0.065		0.126		-0.316	0.201
P	0.645		0.799		0.723		0.753	0.841

Table 2 Comparison of surgical-related indicators between the two groups of patients

Group	Intubation positioning time (min)	One-lung ventilation time (min)	Operation time (min)	Anesthesia time (min)	Hospital stay (d)
SafeLM	3(3 ~ 4)	54.26±19.14	74.51±21.41	98.46±22.87	5.00±1.26
Control	3(3 ~ 4)	54.69±17.83	77.41±20.70	102.35±19.32	5.64±1.51
t/Z	-1.052	-0.104	-0.607	-0.813	-2.036
P	0.293	0.917	0.545	0.419	0.045

Table 3 Comparison of intraoperative and postoperative conditions between the two groups of patients [(x±s),mmHg]

Group	Lung collapse score	Preoperative 1-day QoR15 score	QoR15 score on postoperative day 1	Awaken modified Aldrete score	Postoperative satisfaction
SafeLM	10(9 ~ 10)	142.3±2.57	118(115 ~ 120)	9(9 ~ 10)	4(4 ~ 5)
Control	9(9 ~ 10)	142.9±2.33	109(106 ~ 111)	9(9 ~ 10)	3(3 ~ 4)
t/Z	-0.651	-1.154	-6.868	-0.058	-2.908
P	0.515	0.252	<0.001	0.954	0.004

Note: The lung collapse score was conducted at 10 minutes of one-lung ventilation

Table 4 Comparison of mean arterial pressure between the two groups at different time points [(x±s),mmHg]

Group	T_0	T_1	T_2	T_3	T_4	T_5
SafeLM	96.28±11.57	82.12±12.71	83.76±12.99	79.97±11.70	89.92±12.46	92.20±11.58
Control	102.07±15.20	87.25±15.87	91.15±15.70	80.71±11.34	98.71±14.65	98.10±12.69
t	-1.894	-1.575	-2.263	-0.285	-2.855	-2.143
P	0.060	0.120	0.030	0.780	0.010	0.040

Table 5 Comparison of heart rates at different times between the two groups of patients

Group	T_0	T_1	T_2	T_3	T_4	T_5
SafeLM	73.97±11.14	62.35±11.39	62.76±7.72	62.51±9.59	69.74±9.31	70.33±9.12
Control	71.59±9.87	65.23±9.76	68.05±12.36	61.23±8.85	75.25±13.37	74.66±10.53
t	1.000	-1.195	-2.262	0.613	-2.113	-1.942
P	0.320	0.240	0.030	0.540	0.040	0.060

Table 6 Comparison of airway pressure at different times between the two groups [(x±s),cmH2 O]]

Group	P_1	P_2	P_3
SafeLM	15.97±2.07	18.54±2.78	16.62±2.80
Control	17.77±2.75	21.90±2.44	18.33±2.54
t	-3.258	-5.675	-2.840
P	0.002	<0.001	0.010

Table 7 Comparison of Oxygenation Status at Different Times between the two groups of Patients (%)

Group	T_6	T_7	T_8
SafeLM	99(99 ~ 100)	99(99 ~ 100)	99(99 ~ 100)
Control	99(99 ~ 100)	99(98 ~ 100)	99(99 ~ 100)
Z	-0.600	-0.760	-1.363
P	0.548	0.450	0.173

Table 8 Comparison of the incidence of laryngeal complications and catheter displacement between the two groups [n(%)]

Group	Sore throat	Hoarse	Choking cough	Difficult swallowing	Catheterdis placement
SafeLM	2(5.1)	1(2.6)	1(2.6)	1(2.6)	3(7.7)
Control	17(43.6)	10(25.6)	5(12.8)	2(5.1)	1(2.6)
χ^2	15.656	8.573	2.889	0.347	1.054
P	<0.001	0.003	0.089	0.556	0.305

3 Discussion

In recent years, with the rise of the concept of enhanced r ecovery after surgery (ERAS), there have been an increas ing number of clinical studies on ERAS related to thoraci c surgery [6-7]. The wide development of thoracoscopic surgery has pushed the minimally invasive technology of thoracic surgery to the peak, and one-lung ventilation tec hnology is the core and key of thoracoscopic surgery. At present, double-lumen bronchial intubation is commonly used to achieve lung isolation in thoracic surgery [8], but this method often brings strong stimulation to patients, ca uses severe circulation fluctuations during anesthesia ind uction and recovery, and causes patients' throat discomfo rt such as hoarseness and sore throat [9]. To further reduc e the trauma to patients and promote thoracic surgeries to reach overall minimally invasive levels, this study adopte d the visual laryngeal mask combined with the bronchial occluder for airway management in thoracoscopic partial lung resection surgeries, and observed its clinical effects and advantages in single-lung ventilation thoracoscopic s urgeries.

At present, comfort medicine has become a new trend of medical services, and thoracoscopic minimally invasive t echnology is an important part of the comfort medical sy stem. During thoracoscopic one-lung ventilation surgery, the laryngoscope exposing the glottis, excessive rotation during intubation, secondary stimulation of the glottis an d trachea during extubation, and double-lumen bronchial tube intubation can cause a series of laryngeal complicati ons such as sore throat and hoarseness after surgery, seri ously affecting the patient's comfort. The visual laryngeal mask used in this study does not require the epiglottis to be lifted. Under the guidance of its visual function, it can fully expose the glottis. Moreover, the mask body is relat ively soft and causes little damage to the perilaryngeal tis sues, greatly reducing the incidence of intubation-related adverse reactions such as sore throat [10] and improving the quality of anesthesia. Compared the QoR-15 rehabilit ation quality score and postoperative satisfaction of the t wo groups on the first day after surgery, the experimental group was higher than the control group. The application of visual laryngeal mask combined with bronchial blocke r in thoracoscopic surgery significantly reduces intubatio n-related complications, improves postoperative comfort and satisfaction of patients, and provides a foundation for the rapid recovery of thoracic patients.

Compared with thoracotomy, thoracoscopic surgery has higher requirements for surgical field exposure. Good lun g collapse on the surgical side plays a crucial role in the s uccess of thoracoscopic surgery [11]. In this study, the ef fects of lung collapse after 10 min of single lung ventilati on in the two groups were similar, and both groups could provide a satisfactory surgical field and meet the surgical requirements, which was consistent with literature report s [12]. There was no statistically significant difference in intubation positioning time between the two groups, whic h was different from the results of Wang Jiefeng et al. [1 3], and may be related to the operator's operation method and proficiency level. In the control group, the glottis wa s often exposed by laryngoscope, and the double lumen b ronchial tube was hard in material and special in shape, which increased the difficulty of intubation and often nee ded to be adjusted. However, the curvature of the visual l aryngeal mask was close to the anatomy of the human thr oat, and the visual function was assisted, so the one-time placement success rate was high. However, the glottic po sition of the 5 patients in this study was high, and the bro

nchial occluder was not easy to pass through the glottic due to its fixed Angle. At this time, the assistant could gently press the thyroid cartilage of the patient or moderately lean the head forward of the patient, and the occluder could pass smoothly. No patient had hypoxemia due to the prolonged placement of the bronchial occluder This is a technique for quickly inserting a bronchial occluder.

The double-lumen bronchial tube has a relatively thick diameter, and the insertion and removal process will cause strong stimulation to the patient, especially during insertion, which requires rotation, causing greater damage to the laryngeal and tracheal mucosa. Strong stress reactions will promote the release of catecholamines in the body, leading to increased blood pressure and faster heart rate. The laryngeal mask is easy to place, causes little irritation, and does not expose the glottis. It is a ventilation device on the glottis. The bronchial occluder has a slender tube diameter and uses a high-capacity and low-pressure silicone balloon, which can reduce the irritation and damage to the bronchial mucosa. In this study, the visual laryngeal mask was first inserted, and then the bronchial occluder was placed under the guidance of the adjustable visual function of the visual laryngeal mask. At the end of the operation, the bronchial occluder was removed, and the visual laryngeal mask was retained as the ventilation tool during the recovery period. This significantly reduced the stimulation of the tube to the glottis and tracheal mucosa [14], ensured the stability of circulation during the induction and recovery periods of thoracoscopic surgery patients [15], and reduced the stress response of the patients.Perioperative lung protection strategy is of great significance in thoracoscopic single-lung ventilation surgery, in which low airway pressure is the key. This study compared the airway plateau pressure and oxygenation status at different time points of the two groups. The respiratory parameters were set according to the same coefficient. The oxygenation status of both groups was good, and the difference was not statistically significant ($P > 0.05$). However, the airway plateau pressure of the visual laryngeal mask combined with the bronchial blocker was significantly lower than that of the double-lumen bronchial tube group, which was consistent with the research results of Xie Fenglei et al. [16]. This might be because the material of the double-lumen bronchi is relatively hard and its inner diameter is smaller, thereby increasing the ventilation resistance. This might be because the material of the double-lumen bronchi is relatively hard and its inner diameter is smaller, thereby increasing the ventilation resistance. The diameter of the bronchial occluder is relatively thin, which increases the diameter of mechanical ventilation compared with the tracheal catheter. When the two-lung ventilation is converted to one-lung ventilation, the double-lumen bronchial catheter changes from the original double-lumen to the single lumen, and the ventilation tube diameter is half of the original. while the ventilation tube diameter of the experimental group remains unchanged. It is suggested that compared with double-lumen bronchial tube, laryngeal mask airway combined with bronchial blocker can reduce airway pressure to a certain extent, improve respiratory mechanics, and effectively reduce pulmonary blood shunt rate [17], so as to implement effective lung protection and reduce the occurrence of pulmonary complications. In addition, it has been proved that [18], visual laryngeal mask combined with bronchial occluder can reduce the trauma to patients to a certain extent, reduce the stress response of the body, thereby reducing the release of inflammatory mediators, which is conducive to the early ambulation of patients and effective cough and expectoration, prom

ote the rapid recovery of patients after surgery, and shorten the length of hospital stay.

The application of visual laryngeal mask combined with bronchial occluder in thoracoscopic surgery has obvious advantages. The new visual laryngeal mask used in this experiment has the functions of real-time visualization, intubation and drainage, and its comfort, sealing and manipulation are better [19]. The maximum sealing pressure can reach 35 ~ 40 cmH2 O. During manual lung maneuver, the airway pressure of 25 ~ 30 cmH2 O is used for 5 s, and the lung is expanded well. No postoperative atelectasis occurred [20]. Studies have shown that the self-sealing and displacement of the ordinary laryngeal mask in single-lung ventilation are its major limitations [21]. In this study, when the patient changes positions, the "coaxial transportation" method is adopted, that is, the head is kept in line with the body axis, to minimize the risk of laryngeal mask displacement. If poor ventilation occurs after the lateral position and adjustment is ineffective with the assistance of its visual function, immediate remedial measures should be taken. A single-lumen tracheal tube of the appropriate model should be placed in the ventilation lumen. The intraoperative lung isolation can be achieved through a laryngeal mask, a single-lumen tracheal tube, and a bronchial occluder, ensuring the safe completion of the surgery. Other studies have shown that the common laryngeal mask combined with bronchial occluder is not conducive to attracting secretions and blood in the trachea during partial lung resection, and it is difficult to handle when there is more bleeding or secretions in the trachea [22]. In the experimental group, the visual laryngeal mask, guided by its adjustable real-time visual function, can achieve precise aspiration around the glottis and the cuff. In addition, most of the selected cases in this study were asymptomatic pulmonary nodules found by physical examination and did not involve the main bronchus. The surgical method was relatively simple, with multiple pulmonary wedge resection and short operation time to ensure that the risk of atelectasis caused by unfavorable aspiration was minimized.

In conclusion, the application of visual laryngeal mask airway combined with bronchial blocker in thoracoscopic surgery can not only achieve the same effect of lung collapse as double-lumen bronchial tube, but also reduce the incidence of intubation-related adverse reactions such as sore throat and hoarseness. It has less trauma to patients, better anesthesia quality, higher comfort of patients, shorter hospital stay, and faster postoperative recovery of patients . The visual laryngeal mask airway combined with bronchial blocker can be a better alternative to double-lumen bronchial tube in selected patients and surgical types.

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