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Article

Effect of Thoracoscopic Surgery under Spontaneous Respiration on Inflammatory Indicators and Postoperative Complications in Elderly Patients with Primary Spontaneous Pneumothorax

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Abstract

Background: In thoracoscopic surgery under spontaneous respiration, patients could breathe spontaneously during surgery without the need for mechanical ventilation via tracheal intubation. This technique can effectively avoid the injuries caused by tracheal intubation and mechanical ventilation and the side effects of muscle relaxants, thus reducing postoperative complications and benefitting patients. This study aims to explore the application of thoracoscopic surgery under spontaneous respiration in the elderly with primary spontaneous pneumothorax (PSP) and its effect on inflammatory indices and postoperative complications. **Methods**: The medical records of 181 elderly patients with PSP who underwent thoracoscopic surgery in our hospital from June 2021 to June 2022 were chosen for retrospective analysis. After excluding 15 patients who did not meet inclusion criteria, 80 patients receiving spontaneous respiration via laryngeal mask ventilation were included in the study group and 86 patients undergoing pulmonary ventilation via single-lumen tracheal intubation were included in the control group in accordance with the different schemes used in the surgery. Preoperative anaesthesia induction, surgical and hospitalisation times were compared, and the haemodynamics and inflammatory indices and complication incidences of the two groups were analysed. **Results**: Recovery time and hospitalisation time significantly differed between the two groups ($p < 0.001$). Compared with the control group, the study group had significantly lower mean arterial pressure at T2 and faster heart rates at T2 and T3 ($p < 0.001$). At T5, T6 and T7, the levels of interleukin-6, interleukin-8 and C-reactive protein in the study group were significantly lower than those in the control group ($p < 0.05$). The incidence of intraoperative and postoperative complications did not significantly differ between the two groups ($p > 0.05$). **Conclusion**: Thoracoscopic surgery under spontaneous respiration is safe and effective in the treatment of elderly patients with PSP. It reduces the levels of inflammatory factors and accelerates postoperative rehabilitation, showing certain value for clinical promotion.

Keywords

spontaneous respiration anaesthesia; thoracoscopic surgery; primary spontaneous pneumothorax; inflammatory indices

Introduction

Spontaneous pneumothorax (SP) is a common and major acute disease in thoracic surgery. Its pathological mechanism is as follows: the rupture of pulmonary bullae caused by the sudden increase in intrapulmonary pressure after excessive coughing, breath holding or exercise induces the entry of gas into the pleural cavity, leading to an increase in intrathoracic pressure [1]. This effect, in turn, produces respiratory and circulatory dysfunctions. SP is divided into primary and secondary pneumothorax in accordance with the presence or absence of pulmonary diseases prior to the occurrence of pneumothorax [2,3]. In primary pneumothorax, the lung parenchyma is normal because in the absence of exogenous factors and primary pulmonary disease in lung parenchyma and/or pleura, the spontaneous rupture of pulmonary bullae causes the entry and accumulation of gas into the pleural cavity [4]. Primary spontaneous pneumothorax (PSP), a common pulmonary emergency in clinic, shows annually increasing morbidity and is characterised by recurrent attacks. It seriously threatens the life and health of the elderly.

Thoracoscopic surgery, a main method for the treatment of PSP, adopts general anaesthesia under tracheal intubation; however, this anaesthesia method has high complication incidences and surgical cost, delays postoperative recovery and affects hospitalisation turnover rate and thus does not meet the clinical needs of patients [5]. Nonintubated anaesthesia is a new anaesthesia method that has emerged in recent years. It improves patients' intraoperative compliance and reduces postoperative complications by enabling spontaneous respiration by patients without intubation. Anaesthesia technology under spontaneous respiration has been applied in thoracic surgery [6]. A

Table 1. Case data of selected patients.

Projects	Proportion (%)
Male	166 (75.90)
Female	40 (24.10)
Smoking history	137 (82.53)
Right pneumothorax	81 (48.80)
Left pneumothorax	83 (50.00)
Bilateral pneumothorax	2 (1.20)
Incentives	-
Severe coughing	31 (18.67)
Moving weight	16 (9.64)
Vomiting	14 (8.43)
Sternutation	7 (4.22)
Forced defaecation	1 (0.60)
Imaging data on chest	-
Changes in chronic bronchitis and emphysema	143 (86.14)
Changes in pulmonary bullae	128 (77.11)
Changes in obsolete pulmonary tuberculosis	89 (53.61)
Changes in contralateral destroyed lung	1 (0.60)
Changes in bilateral abnormal density shadow	2 (1.20)
Pleural adhesions	116 (69.88)

growing number of clinical studies have provided strong evidence-based medical evidence for the safety and superiority of spontaneous respiration anaesthesia in thoracic surgery. The objectives of clinical anaesthesia include rapid and complete recovery, early hospital discharge caused by adequate postoperative analgesia and minimised costs associated with postoperative hospitalisation services [7]. However, only a few reports on the application of thoracoscopic surgery under spontaneous respiration in the treatment of elderly patients with PSP exist. Therefore, this study aims to explore the clinical efficacy of thoracoscopic surgery under spontaneous respiration in the treatment of elderly patients with PSP to formulate efficient clinical plans.

Materials and Methods

Research Subjects

The medical records of elderly patients with PSP who underwent thoracoscopic surgery in our hospital from June 2021 to June 2022 were chosen for retrospective analysis.

Inclusion criteria: (1) patients were definitively diagnosed on the basis of chest films and/or lung computed tomography (CT) examination; (2) patients without contraindication to anaesthesia; and (3) patients with complete clinical data. Exclusion criteria: (1) patients with coagulopathy; (2) patients with secondary pneumothorax; and (3) patients with malignant tumours and infectious diseases.

Case Data

The data of 166 elderly patients with PSP are shown in Table 1.

Methods

Preoperative Preparation

Prior to surgery, liver and kidney function, blood routine, urine routine and other examinations, as well as echocardiography and electrocardiography, were performed to evaluate the cardiopulmonary functions of the patients. Preoperative education was given to the patients and their families to inform them of perioperative precautions.

Preoperative Sedation

Atropine sulphate injection (Jiangsu Lianshui Pharmaceutical Co., Ltd.; NMPA approval No.: H32020166; batch number: TT201106964; specification: 1 mL: 0.5 mg; origin: Huai'an, China) at a dose of 0.01 mg/kg was administered through intramuscular injection within half an hour before anaesthesia. After entering the operating room, electrocardiographic examination was performed to monitor patients' heart rate (HR), blood pressure and blood oxygen saturation. Subsequently, a venous channel of the upper limb was established.

Anaesthesia Methods in the Study Group

Patients were injected with dexmedetomidine (Sichuan Guorui Pharmaceutical Co., Ltd.; NMPA ap-

proval No.: H20143195; batch number: 19060633-854; specification: 1 mL: 0.1 mg; origin: Leshan, China) at a dose of 0.3 μg/kg; propofol (Zhejiang Jiuxu Pharmaceutical Co., Ltd.; NMPA approval No.: H20084531; batch number: F96-200110-E; specification: 20 mL: 0.2 g; origin: Jinhua, China) at a dose of 2.5 mg/kg and sufentanil (Yichang Humanwell Pharmaceutical Co., Ltd.; NMPA approval No.: H20054172; batch number: 6369-200816TN; specification: 1 mL: 50 μg × 10/bottle; origin: Yichang, China) at a dose of 0.3 μg/kg for anaesthesia induction. A laryngeal mask was placed by the anaesthetist when the patients were unconscious and the bispectral index (BIS) was less than 50. After the laryngeal mask was placed, propofol was continuously provided through target injection at an initial dose of 0.1–0.2 mg/kg, which was later adjusted until the desired effect was achieved, and 1% sevoflurane (Shanghai Hengrui Medicine Co., Ltd.; NMPA approval No.: H20070172; batch number: 33-6654-200312; origin: Shanghai, China) was inhaled to maintain anaesthesia. The intraoperative BIS of patients was maintained between 40 and 60.

Anaesthesia Methods in the Control Group

Patients were successively injected with 0.3 μg/kg dexmedetomidine, 2.5 mg/kg propofol, 0.3 μg/kg sufentanil and 0.2 mg/kg cisatracurium (Jiangsu Hengrui Pharmaceutical Co., Ltd.; NMPA approval No.: H20060869; batch number: C53-0918-N2O12; specification: 20 mg; location: Lianyungang, China) for anaesthesia induction. When the patients had lost consciousness and the BIS value was <50, the anaesthesiologist placed a single-lumen bronchial tube, accurately positioned the tube through fiberoptic bronchoscopy, fixed the tube and connected the ventilator for one-lung ventilation. The continuous targeted infusion of propofol, inhalation of 1% sevoflurane and intermittent injection of homeopathic atracurium were performed to maintain anaesthesia in accordance with the needs of surgical time. The intraoperative BIS was maintained at 40–60.

Surgical Procedure

The details of the surgical procedure are shown in Fig. 1.

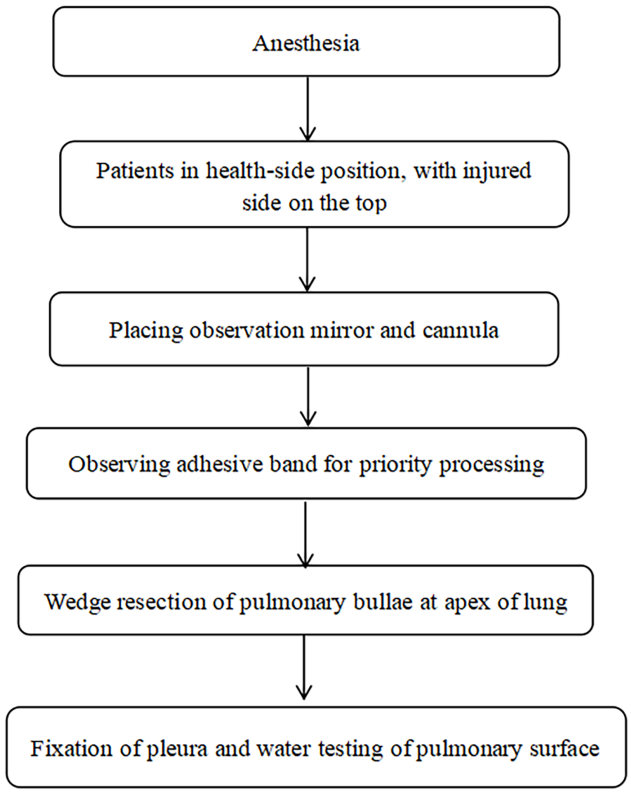

Fig. 1. Procedures of thoracoscopic surgery.

Observation Indicators

Observation Time Points

Eight time points were set: T0 (before anaesthesia), T1 (15 min after one-lung ventilation), T2 (30 min after one-lung ventilation), T3 (30 min after intrathoracic operation completion), T4 (1 h after intrathoracic operation completion), T5 (2 h after surgery), T6 (12 h after surgery) and T7 (24 h after surgery).

Indicator Data

The baseline data of the two groups were compared. The data included age, gender, haemoglobin, anaesthesia time, surgical time, infusion volume, bleeding volume, diffusing capacity of lung for carbon monoxide (DLCO) and forced expiratory volume in one second (FEV1). An automatic biochemical analyser (Shenzhen Mindray Biomedical Electronics Co., Ltd.; batch number: 2019-0091-BS; model: BS-600M; origin: Shenzhen, China) was applied to detect haemoglobin. A detection kit (batch number: P0381M; manufacturer: Beyotime Biological Co., Ltd.; location: Shanghai, China) was also used.

The changes in mean arterial pressure (MAP) and HR at T0–T4 were collected and recorded for comparative analysis.

Blood samples were collected by using tubes without pyrogen and endotoxin. The tubes were placed at room temperature for natural coagulation to separate serum. The obtained serum was centrifuged at 2 °C–6 °C for approximately 20 min (2000–3000 r/min), and the resulting supernatant was collected. An automatic enzyme immunoassay analyser (brand: Biobase; manufacturer: Biobase Biotech [Jinan] Co., Ltd.; batch number: BIO200911-100-96; origin: Jinan, China) was employed to detect the levels of interleukin-6 (IL-6; normal range: 0.37–0.46 ng/L), interleukin-8 (IL-8; normal range: 0.26–0.38 ng/mL) and C-reactive protein (CRP; normal range: 5–10 mg/L) at T5–

Table 2. Comparison of baseline data between the two groups.

Indicators	Study group (n = 80)	Control group (n = 86)	z/χ^2	p
Age [M (P_{25}, P_{75}), years]	67.00 (63.00, 70.75)	66.00 (62.00,70.00)	0.969	0.333
Gender			0.030	0.863
Male (cases)	38 (47.50)	42 (48.84)		
Female (cases)	42 (52.50)	44 (51.16)		
Haemoglobin [M (P_{25}, P_{75}), g/L]	121.42 (106.43, 132.61)	124.54 (109.78, 137.54)	1.399	0.162
Anaesthesia time [M (P_{25}, P_{75}), min]	55.60 (47.13, 62.80)	55.80 (45.73, 63.20)	0.124	0.901
Surgical time [M (P_{25}, P_{75}), min]	42.10 (34.60, 48.58)	41.30 (35.18, 46.43)	0.771	0.441
Bleeding volume [M (P_{25}, P_{75}), mL]	16.00 (14.00, 18.00)	16.00 (14.00, 18.00)	0.376	0.707
DLCO [M (P_{25}, P_{75}), %]	84.30 (79.75, 87.78)	84.15 (78.78, 87.68)	0.953	0.340
FEV1 [M (P_{25}, P_{75}), %]	81.75 (77.00, 86.18)	81.20 (77.93, 85.55)	0.566	0.572
Recovery time [M (P_{25}, P_{75}), min]	8.9 (8.03, 9.68)	12.45 (10.48, 15.30)	9.478	<0.001
Hospitalisation time [M (P_{25}, P_{75}), day]	5.00 (4.00, 6.00)	7.00 (5.00,8.00)	7.942	<0.001

DLCO, diffusing capacity of lung for carbon monoxide; FEV1, forced expiratory volume in one second.

T7 in each group. The kits (manufacturer: Huamei Bioengineering Co., Ltd.; location: Wuhan, China; catalog number of IL-6: IL-6-2245-0514, catalog number of IL-8: IL-8-8543-0401; cata-log number of CRP: A-5241-1214) were used for detection.

The incidences of complications in the two groups were compared and analysed. The analysed complications included intraoperative coughing, reflux aspiration and hypoxaemia during the surgery and re-expansion pulmonary oedema, pulmonary infection, pulmonary alveolar air leakage and throat discomfort after surgery.

Statistical Analysis

SPSS 25.0 software (International Business Machines Corporation; Armonk, NY, USA) was used to analyse and process the collected data. Firstly, the Shapiro–Wilk method was used to test whether continuous variables conformed to the normal distribution. Data meeting non-normal distribution were subjected to nonparametric test and were represented by [M (P_{25}, P_{75})]. For categorical variables, chi-square test or Fisher's test was used and were expressed as [n (%)]. $p < 0.05$ indicates a statistically significant difference. Fig. 1 was drawn by using Microsoft Office Word 2020 (manufacturer: Microsoft Corporation, origin: Redmond, WA, USA).

Results

Comparison of Baseline Data

The comparison and calculation of baseline data revealed no significant differences in age, gender, haemoglobin, anaesthesia time, surgical time, bleeding volume, DLCO and FEV1 between the two groups ($p > 0.05$) and significant differences in recovery and hospitalisation times between the two groups ($p < 0.001$), as detailed in Table 2.

Comparison of Haemodynamics

At T2, the MAP in the study group decreased significantly relative to that in the control group ($p < 0.001$). MAP did not significantly differ between the two groups at other times ($p > 0.05$). The HR levels in the study group at T2 and T3 were significantly lower than those in the control group ($p < 0.001$) and did not significantly differ between the two groups at other times ($p > 0.05$), as shown in Table 3.

Comparison of Inflammatory Indices

Table 4 clearly shows the levels of inflammatory factors in the two groups at different times. The levels of IL-6, IL-8 and CRP in the control group were significantly higher than those in the study group at T5, T6 and T7 ($p < 0.01$).

Incidence of Perioperative Complications

The incidence of intraoperative and postoperative complications did not show significant differences ($p > 0.05$), as depicted in Table 5.

Discussion

This study found that the study group had significantly lower recovery and hospitalisation times than the control group ($p < 0.001$). Moreover, at T2, the MAP of the study group was significantly lower than that of control group. Compared with those of the control group, the HR levels of the study group at T2 and T3 were significantly lower than those the control group ($p < 0.001$). In terms of inflammatory indices, the levels of IL-6, IL-8 and CRP in the study group were significantly lower than those in the control group at T5, T6 and T7 ($p < 0.01$). However, the present results did not reveal significant differences in intraoperative and postoperative complications between the two groups ($p > 0.05$). This finding appears to contradict ex-

Table 3. Comparison of MAP and HR in both groups (M [P_{25}, P_{75}]).

Variables	Groups	T0	T1	T2	T3	T4
MAP (mmHg)	Study group	86.90 (79.80, 93.00)	90.50 (85.20, 99.10)	94.50 (87.10, 100.80)	85.60 (80.40, 93.10)	86.20 (81.20, 88.30)
	Control group	86.50 (80.60, 92.50)	91.40 (84.20, 97.90)	95.50 (89.70, 101.90)	86.70 (80.20, 91.80)	85.60 (80.10, 89.80)
	z	0.788	1.210	15.506	0.891	1.658
	p	0.431	0.226	<0.001	0.373	0.097
HR (times/min)	Study group	69.00 (63.00, 76.00)	70.00 (62.00, 76.00)	76.00 (66.00, 83.00)	72.00 (66.00, 77.00)	71.00 (66.00, 76.00)
	Control group	70.00 (62.00, 78.00)	70.00 (64.00, 75.00)	76.00 (68.00, 86.00)	76.00 (69.00, 84.00)	71.00 (65.00, 78.00)
	z	1.878	0.927	12.953	28.836	0.123
	p	0.060	0.354	<0.001	<0.001	0.902

MAP, mean arterial pressure; HR, heart rate.

Table 4. Comparison of inflammatory indices in both groups at different time points [M (P_{25}, P_{75})].

Variables	Groups	T5	T6	T7
IL-6 (μg/L)	Study group	12.65 (10.13, 14.88)	11.14 (9.20, 12.90)	10.01 (8.55, 12.24)
	Control group	14.56 (13.27, 15.81)	11.62 (10.66, 13.54)	11.71 (9.88, 13.37)
	z	−5.392	−2.595	−3.700
	p	<0.001	0.009	<0.001
IL-8 (μg/L)	Study group	12.16 (11.01, 13.79)	12.40 (10.86, 13.41)	10.79 (9.60, 12.32)
	Control group	14.46 (12.28, 16.36)	12.84 (11.72, 14.02)	11.47 (10.18, 13.27)
	z	−5.392	−2.348	−2.469
	p	<0.001	0.019	0.014
CRP (mg/L)	Study group	14.74 (12.52, 17.82)	12.92 (11.52, 15.69)	11.40 (10.24, 14.20)
	Control group	17.90 (14.85, 19.34)	14.59 (12.60, 17.07)	13.45 (11.14, 14.94)
	z	−4.284	−2.207	−2.085
	p	<0.001	0.027	0.037

IL, interleukin; CRP, C-reactive protein.

pectations. Thoracoscopic technology under nonintubated local anaesthesia and sedation has been gradually applied in the clinic to avoid complications related to tracheal intubation and mechanical ventilation and reduce the hospitalisation cost of patients. Thoracoscopic surgery under spontaneous respiration requires anaesthesiologists to retain the patients' spontaneous respiration under general anaesthesia and no longer uses traditional single-lumen tracheal intubation and ventilator-assisted respiration to avoid the injuries of the trachea and glottis and the barotrauma inflicted by the ventilator on pulmonary alveoli as well as reduce a series of postoperative complications caused by tracheal intubation and ventilator-assisted ventilation [8,9]. Thoracoscopic surgery under spontaneous respiration mainly adopts laryngeal mask ventilation, which could not stimulate the glottis during anaesthesia, by utilising open pneumothorax formed after thoracotomy, showing simple placement, low stimulation to patients' respiratory tracts and good tolerance [10,11].

This study introduced spontaneous respiration via laryngeal mask anaesthesia and emphasised the preservation of the patients' spontaneous respiration to maintain their normal nerve, heart, lung and muscle states [12] and avoid tracheal intubation under anaesthesia. It thus greatly reduces the trauma caused by surgery and anaesthesia operations to patients [13]. This situation is conducive to shortening the postoperative recovery time. In this study, the data showed that the study group had notably lower recovery and hospitalisation times than the control group. This result reflects the superiority of the anaesthesia scheme used in this study. The data also revealed that the MAP and HR of the two groups were statistically significant at T2 and T3 but did not remarkably change in the two groups because their fluctuations were within the normal range. Notably, in the patients in the study group, MAP decreased at 30 min after nerve block, and HR accelerated 30 min after nerve block and at the end of intrathoracic operations, indicating drastic fluctuations in haemodynamics at this time and requiring the close observation of vital signs by anaesthesiologists.

IL-6 induces liver cells to synthesise CRP, accelerating the proteinisation of macrophages and damaging the liver function of patients [14,15]. IL-18 activates T cells and macrophages [16], and the produced cytokines play a certain role in the formation and development of inflammatory responses. The results of this study showed that the inflammatory indices in the study group were significantly lower than those in the control group at T5, T6 and T7 ($p < 0.05$), indicating that thoracoscopic surgery under spontaneous respiration can reduce inflammatory reactions. The levels of inflammatory factors in the two groups gradually decreased with time, suggesting that the postoperative inflammatory status of patients reduces with the prolongation

Table 5. Comparison of complications in both groups [n, %].

Complications	Study group (n = 80)	Control group (n = 86)	R	*p*
During surgery			1.942	0.679
Intraoperative cough	2 (2.50)	1 (1.16)		
Reflux aspiration	1 (1.25)	1 (1.16)		
Hypoxaemia	3 (3.75)	0 (0.00)		
After surgery			1.799	0.802
Recurrent pulmonary oedema	0 (0.00)	1 (1.16)		
Pulmonary infection	1 (1.25)	3 (3.49)		
Pulmonary alveolar air leakage	0 (0.00)	3 (3.49)		
Throat discomfort	2 (2.50)	4 (4.65)		

of time until it returns to within the normal range. This conclusion is consistent with that reported by Janík *et al*. [17], who concluded that the anaesthesia method of spontaneous respiration results in less stimulation to the body than tracheal intubation because in contrast to traditional ventilation through tracheal intubation, general anaesthesia under spontaneous respiration via a laryngeal mask avoids tracheal stimulation, decreases pulmonary damage and injury-induced inflammatory reactions [18,19] and promotes postsurgical recovery.

Nonintubated anaesthesia retains spontaneous respiration under the state of pneumothorax. This condition violates patients' natural physiological states to a certain extent. Therefore, the incidence of intraoperative coughing and hypoxaemia in patients under nonintubated anaesthesia is higher than that in patients with tracheal intubation [20]. The data of this study revealed no significant difference in intraoperative and postoperative complications between the two groups ($p > 0.05$). The reason for this result may be related to the small sample size selected in this study, suggesting that future research should expand the sample size and deeply analyse the effect of this clinical anaesthesia regimen on perioperative complications in patients.

Although this study obtained some results, it still has limitations, such as its limited sample size and the presence of confounding factors (comorbidities, medication and variables that could not be clearly controlled during the study) due to the nature of retrospective analysis. These limitations may introduce potential biases. Furthermore, this study has a short follow-up and lacks in-depth analysis of the patients' long-term prognosis. Given the specific demographic characteristics of the study samples, applying the results of this work to different patient groups may have some limitations, and these factors will have an effect on the further promotion of the study results. As a consequence, subsequent works will expand the sample size, improve the research design, conduct prospective studies and extend the follow-up to obtain conclusions with increased objectivity.

Conclusion

Spontaneous respiration anaesthesia can provide certain benefits to elderly patients with PSP undergoing thoracoscopy. Its application effectively reduces inflammatory response and has a positive importance for improving postoperative rehabilitation.

Availability of Data and Materials

Data to support the findings of this study are available on reasonable request from the corresponding author.

Author Contributions

FX performed the research and provided help and advice on the experiments. YX contributed to data analysis and interpretation. Both authors contributed to editorial changes in the manuscript. Both authors read and approved the final manuscript. Both authors participated sufficiently in the work to take public responsibility for the appropriate portions of its content. Both authors agreed to be accountable for all aspects and questions related to the accuracy or integrity of this work.

Ethics Approval and Consent to Participate

This study was approved by the ethics committee of Jiaozhou Central Hospital of Qingdao (approval no. 20210402). Given that this study was a retrospective analysis, informed consent was not required.

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Conflict of Interest

The authors declare no conflict of interest.

References

[1] Gilday C, Odunayo A, Hespel AM. Spontaneous Pneumothorax: Pathophysiology, Clinical Presentation and Diagnosis. Topics in Companion Animal Medicine. 2021; 45: 100563.

[2] Huan NC, Sidhu C, Thomas R. Pneumothorax: Classification and Etiology. Clinics in Chest Medicine. 2021; 42: 711–727.

[3] DeMaio A, Semaan R. Management of Pneumothorax. Clinics in Chest Medicine. 2021; 42: 729–738.

[4] Gottlieb M, Long B. Managing Spontaneous Pneumothorax. Annals of Emergency Medicine. 2023; 81: 568–576.

[5] Fischer GW, Cohen E. An update on anesthesia for thoracoscopic surgery. Current Opinion in Anaesthesiology. 2010; 23: 7–11.

[6] Deng HY, Zhu ZJ, Wang YC, Wang WP, Ni PZ, Chen LQ. Non-intubated video-assisted thoracoscopic surgery under locoregional anaesthesia for thoracic surgery: a meta-analysis. Interactive Cardiovascular and Thoracic Surgery. 2016; 23: 31–40.

[7] Hung MH, Chen JS, Cheng YJ. Precise anesthesia in thoracoscopic operations. Current Opinion in Anaesthesiology. 2019; 32: 39–43.

[8] Sun M, Gao LJ, Zhang Y, Jing GJ, Liu JL, Ye T, *et al*. Effect of tracheal intubation on postoperative complications in patients with pulmonary hypertension combined with non-cardiothoracic, non-obstetric surgery. Medicine. 2023; 102: e33635.

[9] Baek J, Park SJ, Seo M, Choi EK. Unexpected Tension Pneumothorax after Double-Lumen Endotracheal Intubation in Patients with Pulmonary Edema: A Case Report. Medicina (Kaunas, Lithuania). 2023; 59: 460.

[10] Okuda K, Nakanishi R. The non-intubated anesthesia for airway surgery. Journal of Thoracic Disease. 2016; 8: 3414–3419.

[11] Kiss G, Castillo M. Non-intubated anesthesia in thoracic surgery-technical issues. Annals of Translational Medicine. 2015; 3: 109.

[12] Gelzinis TA, Sullivan EA. Non-Intubated General Anesthesia for Video-Assisted Thoracoscopic Surgery. Journal of Cardiothoracic and Vascular Anesthesia. 2017; 31: 407–408.

[13] Dai X, Song P, Zhang B. Application of Non-intubated Anesthesia in VATS. Zhongguo Fei Ai Za Zhi = Chinese Journal of Lung Cancer. 2016; 19: 312–316. (In Chinese)

[14] Tanaka T, Narazaki M, Kishimoto T. IL-6 in inflammation, immunity, and disease. Cold Spring Harbor Perspectives in Biology. 2014; 6: a016295.

[15] Tanaka T, Narazaki M, Kishimoto T. Interleukin (IL-6) Immunotherapy. Cold Spring Harbor Perspectives in Biology. 2018; 10: a028456.

[16] Baggiolini M, Clark-Lewis I. Interleukin-8, a chemotactic and inflammatory cytokine. FEBS Letters. 1992; 307: 97–101.

[17] Janík M, Juhos P, Lučenič M, Tarabová K. Non-intubated Thoracoscopic Surgery-Pros and Cons. Frontiers in Surgery. 2021; 8: 801718.

[18] Fabo C, Oszlanyi A, Lantos J, Rarosi F, Horvath T, Barta Z, *et al*. Non-intubated Thoracoscopic Surgery-Tips and Tricks From Anesthesiological Aspects: A Mini Review. Frontiers in Surgery. 2022; 8: 818456.

[19] Yu MG, Jing R, Mo YJ, Lin F, Du XK, Ge WY, *et al*. Non-intubated anesthesia in patients undergoing video-assisted thoracoscopic surgery: A systematic review and meta-analysis. PLoS ONE. 2019; 14: e0224737.

[20] Fazzini B, Page A, Pearse R, Puthucheary Z. Prone positioning for non-intubated spontaneously breathing patients with acute hypoxaemic respiratory failure: a systematic review and meta-analysis. British Journal of Anaesthesia. 2022; 128: 352–362.