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Sevoflurane is an effective adjuvant to propofol-based total intravenous anesthesia for attenuating cough reflex in nonintubated video-assisted thoracoscopic surgery

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Abstract

Background: Nonintubated video-assisted thoracic surgery (VATS) has been widely developed during the recent years. Cough reflex is an inevitably encountered problem while approaching lung lesions, and it may induce major bleeding. Sevoflurane anesthesia may attenuate cough reflex by inhibiting the pulmonary irritant receptors. However, the incidence of postoperative nausea and vomiting (PONV) in inhalational anesthesia is higher than in the propofol-based total intravenous anesthesia (TIVA). We investigated the effect of sevoflurane combination with propofol-based TIVA on cough reflex and PONV in nonintubated VATS.

Methods: Ninety patients undergoing nonintubated VATS with laryngeal mask airway (LMA) and spontaneous breathing were randomly assigned for TIVA or propofol/sevoflurane anesthesia. In the TIVA group (n = 45), anesthesia was induced and maintained with propofol and fentanyl; in the propofol/sevoflurane (P/S) group (n = 45), 1% sevoflurane anesthesia was added to propofol and fentanyl anesthesia. The primary outcome measurements were cough reflex. In addition, the incidence of PONV and extubation time were investigated.

Results: Patients with cough reflex were significantly fewer in the P/S group than in the TIVA group (10/45 vs 34/45; $P < .001$). The cough severity (35/5/5/0 vs 11/17/17/0; $P < .001$) and limb movement (40/5/0/0 vs 28/17/0/0; $P < .001$) were lower in the P/S group than in the TIVA group. Besides, incremental fentanyl bolus for cough reflex was 5 (0 [0–1]) in the P/S group and 17 (0 [0–3]) in the TIVA group ($P < .05$). And there was no conversion to general anesthesia, postoperative hemorrhage, aspiration pneumonia, or PONV in the 2 groups. Besides, there was no significant difference in extubation time (TIVA: 5.04 ± 2.88 vs P/S: 4.44 ± 2.98 minutes; $P = .33$).

Conclusion: Sevoflurane attenuated cough reflex under propofol-based TIVA and did not increase the incidence of PONV and extubation time in nonintubated VATS.

Abbreviations: ASA = American Society of Anesthesiology, BIS = bispectral index, BMI = body mass index, Ce = effect-site concentration, $EtCO_2$ = end-tidal carbon dioxide, HR = heart rate, IRB = institutional review board, IV = intravenous, LAST = local anesthetic systemic toxicity, LMA = laryngeal mask airway, LOC = loss of consciousness, MABP = mean arterial blood pressure, NSAIDs = nonsteroidal anti-inflammatory drugs, OLV = one lung ventilation, P/S = propofol/sevoflurane, P/S = propofol/sevoflurane, PONV = postoperative nausea and vomiting, RR = respiratory rate, SD = standard deviation, TCI = target controlled infusion, TEA = thoracic epidural anaesthesia, TIVA = total intravenous anesthesia, VATS = video-assisted thoracic surgery.

Keywords: anesthesia, cough reflex, nonintubated video-assisted thoracic surgery, postoperative nausea and vomiting, propofol, sevoflurane

1. Introduction

The use of nonintubated video-assisted thoracic surgery (VATS) has increased as an important minimally invasive procedure recently, it is feasible and safe in a variety of thoracic procedures, including pulmonary resection, empyema, and excision of pleural and mediastinal tumors.[1] Cough reflex and unexpected lung movement can be encountered during pulmonary manipulation. Using intrathoracic vagal nerve blockade, the cough reflex and unexpected lung movement could be effectively abolished.[2] However, vagal nerve blockade may induce local anesthetic systemic toxicity (LAST), nerve injuries[3], or aspiration.[4,5]

Sevoflurane anesthesia can inhibit the pulmonary irritant receptors and attenuate cough reflex.[6] Unfortunately, sevoflurane anesthesia was associated with a higher incidence of postoperative nausea and vomiting (PONV) compared with propofol-based total intravenous anesthesia (TIVA) in patients undergoing ambulatory surgery.[7] PONV can lead to postoperative complications especially in a patient that cannot tolerate elevated heart rate (HR) or blood pressure, or intrathoracic

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pressure.[8] A previous study reported that TIVA should be well-controlled to balance smooth spontaneous respiration and anesthetic depth.[9] Moreover, TIVA with local anesthesia or thoracic epidural anaesthesia (TEA) is technically feasible and safe in spontaneous breathing VATS.[10] Therefore, propofol-based TIVA is suit for nonintubated VATS with spontaneous breathing.

In the literature, a rigorous comparison of the effects of propofol-based TIVA and propofol/sevoflurane anesthesia on cough reflex and PONV has not yet been performed in VATS. Therefore, in this study, we prospectively compared the effects of propofol-based TIVA and propofol/sevoflurane anesthesia on cough reflex and PONV in patients who underwent nonintubated VATS.

2. Methods

This study was approved by the Ethics Committee (TSGHIRB No: 2-105-05-010) of Tri-Service General Hospital, Taipei, Taiwan (Chairman, Professor Yu Mu Hsien) on March 14, 2016. All patients provided written informed consent before being enrolled. All methods were performed in accordance with the relevant guidelines and regulations by our IRB.

From April 2016 to November 2017, 90 patients in our medical center scheduled to undergo nonintubaed VATS by one surgeon under spontaneous breathing anesthesia with laryngeal mask airway (LMA) were enrolled in this study. Patients were randomized 1:1 into the propofol-based TIVA (TIVA group) or propofol/sevoflurane anesthesia groups (P/S group) by using a table of random, computer-generated digits in sealed and numbered envelopes by an anesthesiologist. Participants and the surgeon were blinded after assignment to interventions. Exclusion criteria were as follows: age < 20 years or older than 80 years, American Society of Anesthesiologists (ASA) physical status of more than III, body mass index (BMI) $> 30\,kg/m^2$, possible pregnancy, emergent surgeries, uremia, liver disease, and the presence of congenital or acquired oropharyngeal malformations.

All patients fasted overnight before surgery, and there was no premedication before induction of anesthesia. Regular monitoring, such as noninvasive arterial blood pressure, electrocardiography (lead II), pulse oximetry, end-tidal carbon dioxide pressure ($EtCO_2$) were applied in each patient. Intra-arterial blood pressure monitoring was used to patients undergoing lobectomy. Anesthesia was induced with fentanyl and propofol in all patients, then maintained with propofol or propofol/sevoflurane after LMA insertion. All procedures were performed with the patient in the lateral decubitus position. Besides, all patients were moniotored under bispectral index (BIS).

Before surgery, all patients were given thoracic epidural catheters inserted into the T7-8 or T8-9 space with the test dose (2 mL) of 2% lidocaine only for postoperative patient-controlled epidural analgesia use.[10] In the TIVA group, anesthesia was induced using intravenous (IV) fentanyl 100 μg (50 μg for thoracic epidural catheter insertion and 50 μg for LMA insertion).[11] Continuous infusion of propofol was delivered subsequently using Schneider's kinetic model of target-controlled infusion (TCI; Fresenius Orchestra Primea; Fresenius Kabi AG, Bad Homburg, Germany) with the effect-site concentration (Ce) of 4.0 μg/mL.[12] Anesthesia was maintained using TCI with propofol infusion and spontaneous breathing with 1.0 L/min flow (100% oxygen). In the P/S group, the anesthesia induction were as the TIVA group patients, whereas anesthesia was maintained using propofol infusion and fixed 1% sevoflurane (inhaled concentration) with an oxygen flow of 1 L/min with 100% oxygen.[13]

Maintenance of the Ce for the TIVA and P/S was adjusted to keep BIS value between 40 and 60, mean arterial blood pressure (MABP) and HR at baseline levels ± 20%.[11,13] The SpO_2 was maintained $\geqq$ 90%.[14] Incremental intravenous injections of fentanyl (25 μg) were administrated as: the presence of moderate to severe cough with limb movement affecting the surgical procedure, to keep a respiratory rate (RR) of 12 to 20 breaths/min.[9,11]

All patients received the intraoperative multilevel thoracoscopic intercostal nerve blocks administered through the working port by infiltration of 0.5% bupivacaine (1.5 mL for each intercostal space) from the third to the 8th intercostal nerve under the parietal pleura, 2 cm lateral to the sympathetic chain by the surgeon. Keterolac 30 mg IV was administrated to the patients without nonsteroidal anti-inflammatory drugs (NSAIDs) allergy before skin closure.

At the end of the procedure, propofol and sevoflurane were discontinued and the lungs were ventilated with 100% oxygen at a fresh gas flow of 6 L/min. When the patient regained consciousness by name, the LMA was removed and the patient was sent to the postoperative anesthesia care unit for further care.

The primary outcome measurements were the incidence of cough reflex. Cough severity (1 = none, 2 = slight, 3 = moderate, 4 = severe) and limb movement (1 = none, 2 = slight, 3 = moderate, 4 = severe) were recorded during the surgery.[15] In addition, the incidence of PONV within 24 hours after surgery, extubation time, loss of consciousness (LOC) Ce of propofol during induction, awakening Ce of propofol, maintenance Ce of propofol, maintenance end-tidal (Et) concentration of sevoflurane (%), awakening Et concentration of sevoflurane (%), and fentanyl bolus for cough reflex and limb movement, fentanyl and propofol consumption were recorded. We also recorded the pulmonary lesions as central or peripheral by chest x-ray.[16]

Based on the same surgical population in our institution, a power analysis was performed by reducing cough reflex and limb movement as the primary variable. We calculated a sample size so that a reducing 50% of cough reflex and limb movement would permit a one-tailed type I error rate of $\alpha = 0.05$ with a power of 80%. This analysis indicated that a sample size of at least 37 patients per group was necessary. To allow for potential dropouts, we enrolled a total of 45 patients in each group. Data are presented as the mean and standard deviation (SD) or number of patients. Demographic and perioperative variables were compared using Student's *t*-tests or Mann–Whitney test while the data were not normally distributed. Categorical variables were compared using chi-square. Differences in the severity of symptoms between 2 groups were evaluated by Kruskal–Wallis tests. Furthermore, the Dunn's procedure was applied to compare the difference between 2 groups. Statistical significance was accepted for 2-tailed P values of < 0.05. The statistics was performed by using SigmaStat 3.5 for Windows.

3. Results

Ninety patients undergoing elective nonintubated VATS with LMA and spontaneous breathing were performed successfully without excluded. Ultimately, 90 patients completed the study: 45 in the TIVA group and 45 in the P/S group (Fig. 1).

The 2 groups showed similar patients' characteristics and surgical procedures (Table 1). Table 2 showed comparison of

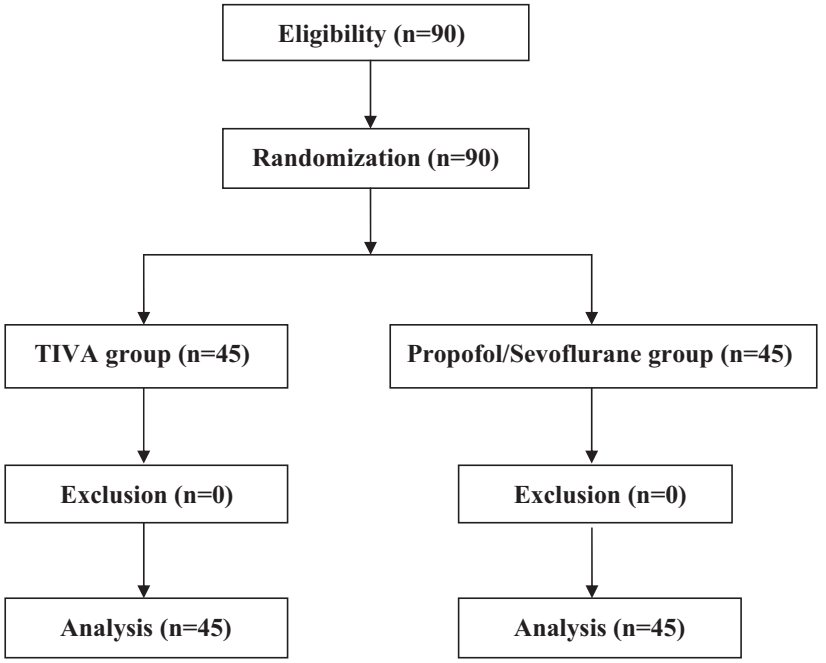

Figure 1. Flow diagram showing patient flow according to the study protocol.

perioperative characteristics and outcomes for the 2 groups. There was no significant difference between the 2 groups in terms of (1) operation time (TIVA group: 69.2 ± 24.4 vs P/S group: 67.8 ± 25.1 minutes, $P = .80$), (2) anesthesia time (TIVA group: 102.8 ± 29.8 vs P/S group: 102.4 ± 30.2 minutes, $P = .95$), (3) extubation time (TIVA group: 5.04 ± 2.88 vs P/S group: 4.44 ± 2.98 minutes, $P = .33$), and (4) the LOC propofol Ce (TIVA group: 3.46 ± 0.44 vs P/S group: 3.46 ± 0.51 μg/mL, $P = .98$). The maintenance propofol Ce was 2.66 ± 0.46 in the TIVA group and 2.38 ± 0.48 μg/mL in the P/S group ($P < .05$). Maintenance and awakening Et concentration of sevoflurane in the P/S group was 0.7 and 0.13 ± 0.06%, respectively. The awakening propofol Ce was 0.96 ± 0.15 μg/mL in the TIVA group and 0.73 ± 0.16 μg/mL in the P/S groups ($P < .001$). Fentanyl consumption during the procedure was 145.0 ± 41.1 μg in the TIVA group and 128.3 ±

Table 1

Patient's characteristics and surgical procedures.

	Group TIVA (n = 45)	Group P/S (n = 45)	*P* value
ASA I/ II/III	0/42/3	0/42/3	
Gender (M/F)	18/27	17/28	.83
Age, y/o	56.5 ± 14.5	55.7 ± 13.4	.79
Height, cm	161.7 ± 7.7	161.8 ± 9.1	.94
Weight, kg	59.9 ± 9.7	59.8 ± 11.9	.97
Smoker	5	10	.14
Surgical procedures			
VATS with wedge resection	39	38	
VATS with segmentectomy	5	6	
VATS with lobectomy	1	1	
Location			
Central/peripheral lesions	6/39	7/38	.76
Right upper lobe	13 (28.9%)	12 (26.7%)	
Right middle lobe	7 (15.6%)	7 (15.6%)	
Right lower lobe	12 (26.7%)	11 (24.4%)	
Left upper lobe	9 (20.0%)	8 (17.8%)	
Left lower lobe	4 (8.9%)	7 (15.6%)	

Data shown as mean ± SD or number or percentage.
ASA = American Society of Anesthesiologists, P/S = propofol/sevoflurane, TIVA = total intravenous anesthesia, VATS = video-assisted thoracoscopic surgery.

Table 2

Comparison of perioperative characteristics and outcomes for the 2 groups.

	Group TIVA (n = 45)	Group P/S (n = 45)	*P* value
Operation time, minutes	69.2 ± 24.4	67.8 ± 25.1	.80
Anaesthesia time, minutes	102.8 ± 29.8	102.4 ± 30.2	.95
Extubation time, minutes	5.04 ± 2.88	4.44 ± 2.98	.33
LOC propofol Ce, μg/mL	3.46 ± 0.44	3.46 ± 0.51	.98
Maintenance propofol Ce, μg/mL	2.66 ± 0.46	2.38 ± 0.48	< .05
Maintenance Et SEVO (%)	0	0.7	
Awakening propofol Ce, μg/mL	0.96 ± 0.15	0.73 ± 0.16	< .001
Awakening Et SEVO (%)	0	0.13 ± 0.06	
Fentanyl consumption, μg	145.0 ± 41.1	128.3 ± 31.4	< .05
Fentanyl bolus for cough reflex (n; median [range])	17 (0 [0–3])	5 (0 [0–1])	< .05
Propofol consumption, mg	579.0 ± 157.6	525.6 ± 164.8	.12
Patients with cough reflex (n; %)	34 (75.6%)	10 (22.2%)	< .001
Cough severity (1/2/3/4)	11/17/17/0	35/5/5/0	< .001
Limbmovement (1/2/3/4)	28/17/0/0	40/5/0/0	< .001
Cough reflex in central lung lesions	6/6 (100.0%)	4/7 (57.1%)	.07
Cough reflex in peripheral lung lesions	28/39 (71.8%)	6/38 (15.8%)	< .001
Patients with PONV (n)	0	0	

Data shown as mean ± SD or number, or median (range).
Ce = effect-site concentration, Et = end-tidal, LOC = loss of consciousness, P/S = propofol/sevoflurane, PONV = postoperative nausea and vomiting, SEVO = sevoflurane, TIVA = total intravenous anesthesia.

Table 3

Anesthetic, hemodynamic, and respiratory data before OLV and during surgery for the 2 groups.

	Group TIVA (n = 45)	Group P/S (n = 45)	*P* value
BIS			
Before OLV	48.2 ± 2.4	48.0 ± 2.4	.73
During surgery	49.3 ± 1.7	49.2 ± 1.4	.79
Ce of propofol, μg/mL			
Before OLV	2.64 ± 0.45	2.37 ± 0.46	<.05
During surgery	2.71 ± 0.47	2.40 ± 0.49	<.05
Et sevoflurane (%)			
Before OLV	0	0.7	
During surgery	0	0.7	
Heart rate, beats/min			
Before OLV	76.9 ± 5.8	75.6 ± 6.8	.36
During surgery	81.3 ± 6.0	80.0 ± 6.9	.35
MABP			
Before OLV	83.1 ± 3.6	83.3 ± 3.1	.75
During surgery	84.1 ± 4.1	84.4 ± 3.2	.67
Respiratory rate			
Before OLV	13.9 ± 1.6	13.4 ± 1.5	.11
During surgery	16.9 ± 1.9	16.3 ± 2.0	.12

Data shown as mean ± SD or number.

BIS = bispectral index, Ce = effect-site concentration, Et = end-tidal, MABP = mean arterial blood pressure, OLV = one lung ventilation, P/S = propofol/sevoflurane, TIVA = total intravenous anesthesia.

31.4 μg in the P/S group ($P < .05$). Incremental fentanyl bolus for moderate to severe cough and limb movement during the procedure was 17 (0 [0–3]) in the TIVA group and 5 (0 [0–1]) in the P/S group ($P < .05$). Propofol consumption during the procedure was 579.0 ± 157.6 mg in the TIVA group and 525.6 ± 164.8 mg in the P/S group ($P = .12$). There was no significant difference in lesion location. Central/peripheral lung lesions were 6/39 in the TIVA group and 7/38 in the P/S group ($P = .76$).

Table 2 showed that patients with cough reflex were significantly fewer in the P/S group than in the TIVA group (10/45 vs 34/45; $P < .001$). In addition, the cough severity (1/2/3/4) were higher in the TIVA group (11/17/17/0) than in the P/S group (35/5/5/0; $P < .001$). Consistently, the limb movements (1/2/3/4) were higher in the TIVA group (28/17/0/0) than in the P/S group (40/5/0/0; $P < .001$). The incidence of cough reflex in central lung lesions was 100% (6/6) in the TIVA group and 57.1% (4/7) in the P/S group ($P = .07$); the incidence of cough reflex in peripheral lung lesions was 71.8% (28/39) in the TIVA group and 15.8% (6/38) in the P/S group ($P < .001$). In the TIVA group, the incidence of cough reflex in central lesions was similar with that in the peripheral lesions (6/6 vs 28/39; $P = .13$). However, the incidence of cough reflex in central lesions was significantly higher than in the peripheral lesions (4/7 vs 6/38; $P < .05$) in the P/S group.

Table 3 showed comparison of anesthetic, hemodynamic, respiratory, and BIS data before one lung ventilation (OLV) and during surgery (manipulation of lung) between the 2 groups. Before OLV, the Ce of propofol was 2.37 ± 0.46 μg/mL in the P/S group and 2.64 ± 0.45 μg/mL in the TIVA group ($P < .05$); during surgery, the Ce of propofol was 2.40 ± 0.49 μg/mL in the P/S group and 2.71 ± 0.47 μg/mL in the TIVA group ($P < .05$). Before OLV and during surgery, there were no significant differences in BIS value, MABP, HR, and RR between the 2 groups. Besides, Et sevoflurane was both 0.7% in the P/S group before OLV and during surgery.

4. Discussion

The major findings of this study revealed that combination with 1% sevoflurane anesthesia attenuated cough reflex under propofol-based TIVA in nonintubated VATS. In addition, we also found that propofol combination with1% sevoflurane anesthesia did not increase the incidence of PONV and extubation time in nonintubated VATS under BIS monitoring.

Coughing is initiated by activation of mechanically and chemically sensitive vagal afferent nerves innervating the airways. All afferent nerve subtypes innervating the airways can modulate the cough reflex. At present, vagal bronchopulmonary afferent nerves are typically considered to belong to one of 3 general categories, namely C-fibres, rapidly adapting receptors, and slowly adapting stretch receptors.[17] Vagal block ensures cough abolition during 12 hours so most anatomical resections can be safely performed. It is better to block the vagal transmission before initiating parenchyma or bronchial pulling maneuvers in order to avoid cough reflex triggering.[18] Some other techniques have been described for cough control, such as intravenous or aerosolized local anesthetic.[19] but they are less effective than direct vagal block.[18] However, nerve blockade may induce LAST, nerve injuries,[3] or aspiration.[4,5] For these reasons, the routine use of vagal block is not recommended by our surgeon, and anesthetics that attenuate cough reflex are usually requested, especially for nonintubated VATS.

Chen et al[20] routinely performed intraoperative thorascopic vagal block for cough reflex suppression. For the sake of decreasing cough suppression duration, incremental intravenous fentanyl is applied in place of vagal block,[11] because cough suppression is part of the pharmacodynamic profile of fentanyl.[21] Tagaito et al[22] found that increasing doses of fentanyl in subjects under propofol anaesthesia modified upper airway reflexes, with the cough reflex being the most susceptible even at doses of 50 μg, and that after 4 doses (total 200 μg fentanyl) only slight adduction of the vocal folds for airway closure was observed endoscopically following instillation of distilled water into the larynx. However, most serious adverse effects of fentanyl are dose-dependent respiratory depression and aspiration pneumonia.[21] Therefore, higher dose of fentanyl use is not suit for nonintubated VATS with LMA and spontaneous breathing. The fentanyl consumption was less than 200 μg, and there was no aspiration pneumonia in this study. Though the cough reflex was suppressed by fentanyl in our study, the optimal and maximal doses of fentanyl for cough reflex suppression in nonintubated VATS were needed to investigate.

Here, we first found that sevoflurane can attenuate cough reflex without vagal block. Cough reflex is one of the first challenges while facing nonintubated VATS. It seems that dissecting vascular structures without cough control is not safe due to the risk of a major bleeding.[18] The lower airway contains specific cough-producing receptors/fibers such as slowly adapting stretch receptors, rapidly adapting receptors (irritant receptors) and pulmonary C-fibers.[23–25] Also, laryngeal irritant receptors and C-fibers presented in the upper airway participate in cough reflexes.[26] Among these, pulmonary and laryngeal irritant receptors are the main afferents most readily associated with the cough reflex.[26] Sevoflurane anesthesia can inhibit the pulmonary irritant receptors and attenuate cough reflex.[6] In contrast, cough reflex occurred significantly more frequently in propofol anesthesia compared with sevoflurane anesthesia in a stimulation technique.[27] Furthermore, subanesthetic concentration of sevoflurane might attenuate cough reflex via reducing agonist affinity at nicotinic acetylcholine receptors on vagal afferent

neurons in the brain site.[17,28,29] Therefore, we think that the effect of cough reflex suppression in the P/S group was based on sevoflurane inhibiting the pulmonary irritant receptors compared with propofol. Taking together, we used fentanyl and sevoflurane for modifying depth of anesthesia to attenuate cough and the result was consistent with previous studies reporting that depth of anesthesia can modify cough reflex.[30–32] However, there was no significant difference in BIS value between 2 groups before OLV and during surgery in this study.

In this study, the overall incidence of cough reflex in central lung lesions was 76.9% (10/13) with small sample size, and sevoflurane attenuated cough reflex in the central lesion without statistical significance (100% vs 57.1%; $P = .07$). Therefore, we suggested that vagal block was needed in central lung lesions for attenuating cough reflex. In addition, we showed that the cough reflex was significantly suppressed in the peripheral lesion by sevoflurane (71.8% vs 15.8%). Thus, we concluded that subanesthetic of sevoflurane might be applied in place of vagal block in nonintubated VATS under propofol-based TIVA and BIS monitoring for peripheral lung lesions. From another point of view, Dong et al[33] reported that the incidence of cough reflex resulting from lobe traction without vagal block was 9.1% (2/22) in nonintubated VATS under remifentanil and propofol anesthesia combination with TEA. We did not use remifentanil in this study due to remifentanil available in our country since 2018, and further investigation was needed.

Sevoflurane and propofol had similar efficacy for anesthesia, nevertheless, propofol based TIVA may still be the preferred anesthetic because of its favorable anesthesia characteristics, such as high patient satisfaction and less frequent incidence of PONV.[13,34–36] In this study, we found no patient with PONV in the 2 groups. This finding may be resulting from that the patients received propofol/sevoflurane anesthesia, the anesthetic technique was propofol predominant and adjuvant sevoflurane. As our best knowledge, however, the optimal concentration of sevoflurane for attenuating cough reflex and PONV in nonintubated VATS remains unclear and need to further investigate.

This study has some limitations. First, ninety patients received different surgical procedures (77 patients undergoing VATS with wedge resection, 11 patients undergoing VATS with segmentectomy, and 2 patients undergoing VATS with lobectomy). However, such a dicrepancy between the TIVA and P/S groups was minimal due to 39/38 patients undergoing VATS with wedge resection, 5/6 patients undergoing VATS with segmentectomy, and 1/1 patient undergoing VATS with lobetomy. Second, we did not exclude smokers. Cough reflex sensitivity might be diminished in current-smokers compared with nonsmokers.[37,38] One proposed mechanism, chronic cigarette smoke-induced desensitization of airway cough receptors, is supported by the demonstration that smoking cessation leads to prompt enhancement of cough reflex sensitivity, even after many years of smoking.[38] However, number of smokers was no significantly different between 2 groups. Third, our study was underpowered for PONV.[39] We did not see any PONV in the 2 groups, and further investigation is needed. Finally, NSAIDs might attenuate cough reflex,[40,41] however, we used NSAIDs just before skin closure for better patient survival.[42]

In conclusion, we showed that combination with 1% sevoflurane anesthesia and propofol anesthesia attenuated cough reflex during nonintubated VATS. Besides, we found no significant difference in extubation time between 2 groups under BIS monitoring, no postoperative hemorrhage, and no PONV in the 2 groups. It might suggest the acceptable clinical effect on the propofol combination with 1% sevoflurane anesthesia in nonintubated VATS with LMA and spontaneous breathing.

Author contributions

Conceptualization: Hou-Chuan Lai, Zhi-Fu Wu.
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Resources: Tsai-Wang Huang.
Supervision: Zhi-Fu Wu.
Writing – original draft: Hou-Chuan Lai.
Writing – review & editing: Zhi-Fu Wu.

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