Is there a benefit of awake thoracoscopic surgery in patients with secondary spontaneous pneumothorax?

Masafumi Noda, MD, PhD, Yoshinori Okada, MD, PhD, Sumiko Maeda, MD, Tetsu Sado, MD, PhD, Akira Sakurada, MD, PhD, Yasushi Hoshikawa, MD, PhD, Chiaki Endo, MD, PhD, and Takashi Kondo, MD, PhD

Objectives: The purpose of the present study was to retrospectively compare the outcomes of video-assisted thoracic surgery in awake and anesthetized patients in the treatment of secondary spontaneous pneumothorax.

Methods: A total of 57 consecutive patients who underwent video-assisted thoracic surgery for secondary spontaneous pneumothorax was retrospectively analyzed. Of these patients, 15 underwent surgery under epidural and/or local anesthesia (ELA) and 42 under general anesthesia. Using propensity score matching, we identified comparable patient groups: the ELA group and general anesthesia group ($n = 8$ each). We compared the duration of operating room stay, operating time, postoperative hematologic data on postoperative day 1, postoperative complications, duration of hospital stay, and the incidence of hospital death between the ELA and general anesthesia groups.

Results: After propensity score matching, the duration of operating room stay was significantly shorter in the ELA group ($P = .006$). The incidence of postoperative respiratory complications, including pneumonia and acute respiratory distress syndrome, was lower in the ELA group ($P = .02$). The duration of postoperative hospital stay and the incidence of hospital death were not different between the 2 groups.

Conclusions: The ELA group had a lower incidence of postoperative respiratory complications. Awake video-assisted thoracic surgery can be performed with an acceptable overall morbidity for patients with secondary spontaneous pneumothorax. (J Thorac Cardiovasc Surg 2012;143:613-6)

Secondary spontaneous pneumothorax (SSP) accompanying a severe underlying lung disease is occasionally lethal. Conservative treatment, such as chemical pleurodesis, is often chosen as a first therapy in such cases; however, surgical treatment is sometimes required for patients with intractable SSP. Although video-assisted thoracic surgery (VATS) for SSP has usually been performed under general anesthesia (GA), VATS procedures under epidural and local anesthesia (ELA) have been reported to avoid the perceived increased risk of GA in patients with SSP.¹⁻³ To date, no study has compared the outcomes of VATS for SSP using ELA versus GA. The aim of the present study was to retrospectively compare the efficacy, morbidity, and mortality of VATS using the 2 anesthetic techniques (ELA and GA) in the treatment of SSP using a propensity score-matching analysis.^{4,5}

MATERIALS AND METHODS

From 2005 to 2010, 57 consecutive patients underwent VATS for SSP at the Tohoku University. Of these patients, 15 underwent surgery under ELA and 42 under GA. The surgical indications of these patients were SSP with persistent air leak for more than 7 days. The patient characteristics are listed in Table 1. Although we have not established definite criteria to determine the indication for ELA or GA, ELA was applied to patients with a more compromised general condition, as shown by the performance status⁶ ($P = .009$) and oxygen requirement ($P = .0002$) in each group (Table 1). Preoperative chemical pleurodesis and/or an autologous blood patch was more frequently applied to patients in the ELA group than in the GA group ($P = .02$). No notable differences were found in age, gender, or the duration of preoperative hospital stay between the 2 groups. Next, to compensate for the difference in the patient characteristics of the 2 groups in the present retrospective, nonrandomized study, we used a propensity score-matching analysis to minimize the selection bias between the ELA and GA groups. The variables for calculating the propensity score included age, gender, duration of preoperative hospital stay, preoperative performance status, preoperative chemical and/or autologous blood patch, and the amount of oxygen required. From these variables, the propensity score was estimated for each patient using a logistic regression model. Our study matched subjects using a caliper width within 0.06 of the propensity score.⁷ Using this method, comparable patient groups ($n = 8$ each) were identified. The baseline characteristics of the propensity score-matched pairs were almost identical (Table 2). All medical records were analyzed for intra- and postoperative factors, consisting of operating room stay, operating time, postoperative hematologic data on day 1, postoperative complications, including prolonged air leak and respiratory complications, postoperative hospital stay, and hospital death. These factors were compared between the ELA and GA groups.

From the Department of Thoracic Surgery, Institute of Development, Aging and Cancer, Tohoku University, Sendai, Japan.

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Address for reprints: Masafumi Noda, MD, Department of Thoracic Surgery, Institute of Development, Aging and Cancer, 4-1 Seiryomachi, Aoba-ku, Sendai, Miyagi 980-8575, Japan (E-mail: noda.m@idac.tohoku.ac.jp).

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Abbreviations and Acronyms

ARDS = acute respiratory distress syndrome
 ELA = epidural and/or local anesthesia
 GA = general anesthesia
 SSP = secondary spontaneous pneumothorax
 VATS = video-assisted thoracic surgery

SURGICAL PROCEDURE UNDER ELA

An epidural catheter was inserted at the T3–T6 level before surgery. A continuous infusion of 0.2% ropivacaine was started. To identify any air leak points, a preoperative thoracography using iopamidol (Iopamiron 300; Schering AG, Berlin, Germany) was performed through a double-lumen chest tube. Ventilation was maintained by spontaneous breathing throughout the operation, with oxygen supplement to maintain oxygen saturation greater than 94%. The patients were placed in the supine position or the lateral decubitus position, when possible. Local anesthesia with 1% lidocaine was administered, after which a 5-mm port was inserted in the intercostal space at the midclavicular line. A 5-mm, 30° end-viewing flexible scope (LTF-260; Olympus, Tokyo, Japan) was introduced through the port. When desaturation was noted on the monitor, the lung was temporarily re-expanded by sucking the air in the pleural cavity through the double-lumen chest drainage tube. A second small incision was made in the intercostal space at the anterior axillary line. A Roeder loop was introduced to ligate a ruptured bulla. When the air leak point was not suitable for ligation, the area was stapled using an Endo-GIA stapling device (Tyco Healthcare Japan, Tokyo, Japan) inserted through a third small intercostal incision. The area of ligation or the staple line was also reinforced with nonwoven polyglycolic acid sheets (Neoveil; Gunze, Ayabe, Japan) and fibrin glue.

SURGICAL PROCEDURE UNDER GA

Both epidural and GA were administered to the patient and 1-lung ventilation was performed using a double-lumen endotracheal tube. The patient was placed in the lateral decubitus position, bullae, or blebs were identified and stapled using an Endo-GIA stapler through either a standard 3-port VATS or minithoracotomy. The staple line was reinforced with polyglycolic acid sheets and fibrin glue.

In all cases, a 20F or 24F chest tube was inserted through an inferior incision and placed at the pleural apex. The chest bottles were connected to a negative suction of –10 cm H₂O postoperatively until the air leak stopped. Postoperative analgesia was basically accomplished by continuous infusion of ropivacaine using the epidural catheter for 3 to 5 days in both groups of patients. Additional analgesics

TABLE 1. Preoperative patient characteristics

Variable	ELA (n = 15)	GA (n = 42)	P value
Age (y)	69.9 ± 17.2	61.0 ± 11.3	.058
Gender (n)			.32
Male	10	37	
Female	3	5	
Preoperative hospital stay (days)	14.6 ± 16.1	13.9 ± 0.8	.85
Preoperative performance status (n)	2.0 ± 0.8	1.0 ± 1.3	.009*
Preoperative chemical pleurodesis	11	15	.02*
Oxygen requirement (L/min)	2.9 ± 1.5	1.1 ± 1.5	.0002
Underlying lung disease (n)	8	29	
COPD/IP	5	8	
LAM	1	1	
BO	1	2	
Sarcoidosis	0	1	
Metastatic lymph nodes	0	1	

ELA, Epidural and/or local anesthesia; GA, general anesthesia; COPD, chronic obstructive pulmonary disease; IP, interstitial pneumonia; LAM, lymphangioleiomyomatosis; BO, bronchiolitis obliterans. *Statistically significant difference.

consisting of nonsteroidal anti-inflammatory drugs and/or opioids were given when needed. For postoperative persistent air leak of longer than 3 days, chemical pleurodesis with OK-432 was performed. Prolonged air leakage was defined as persistent air leakage for longer than 7 days after the operation.

STATISTICAL ANALYSIS

All statistical analyses were performed using JMP, version 9, for Windows (JMP, Cary, NC). All data are presented as the mean ± SD or the prevalence of applicable patients in the variables. The differences between the groups were analyzed using Student's *t* test for continuous variables and the χ^2 test for categorical variables. *P* < .05 was considered to be statistically significant.

TABLE 2. Preoperative patient characteristics after propensity score matching

Variable	ELA (n = 8)	GA (n = 8)	P value
Age (y)	67.6 ± 6.4	65.5 ± 16.6	.81
Gender (n)			1.0
Male	7	7	
Female	1	1	
Preoperative hospital stay (days)	12.4 ± 8.9	17.9 ± 12.5	.33
Preoperative performance status	2.1 ± 0.8	2.0 ± 1.3	.82
Preoperative chemical pleurodesis	6 (75.0)	7 (87.5)	.52
Oxygen requirement (L/min)	2.4 ± 1.7	2.8 ± 1.7	.66

Data in parentheses are percentages. ELA, Epidural and/or local anesthesia; GA, general anesthesia.

TABLE 3. Perioperative outcomes

Variable	Entire study sample			Propensity score-matched pairs		
	ELA (n = 15)	GA (n = 42)	P value	ELA (n = 8)	GA (n = 8)	P value
Operating room stay (min)	116.5 ± 35.2	209.1 ± 77.1	< .0001*	109.8 ± 40.9	222.4 ± 88.4	.006*
Operating time (min)	85.9 ± 35.3	111.4 ± 56.1	.12	87.8 ± 45.9	111.5 ± 54.3	.36
White blood cell on POD 1 (/μL)	9042 ± 893	11105 ± 513	.052	8883 ± 3448	11,385 ± 3980	.11
C-reactive protein on POD1 (mg/dL)	3.93 ± 2.22	6.01 ± 0.59	.07	4.3 ± 2.5	7.0 ± 4.3	.14
Postoperative complication						
Prolonged air leak	4	3	.05*	2	3	.60
Respiratory complications	0	10	.046*	0	4	.02*
Pneumonia	0	8		0	2	
ARDS	0	2		0	2	
Postoperative hospital stay (d)	26.3 ± 33.8	17.3 ± 13.0	.17	19.1 ± 25.4	24.3 ± 14.9	.7
Hospital death	0	4	.25	0	3	.06
Pneumonia	0	2		0	1	
ARDS	0	2		0	2	

ELA, Epidural and/or local anesthesia; GA, general anesthesia; POD, postoperative day; ARDS, acute respiratory distress syndrome. *Statistically significant difference.

RESULTS

Entire Patient Study

The perioperative outcomes in the ELA and GA groups are summarized in Table 3. No significant difference was found in the operating time between the 2 groups. However, the operating room stay was significantly shorter in the ELA group ($P < .0001$). The patients in the ELA group did not show a significant difference in white blood cell count ($P = .052$) or C-reactive protein ($P = .07$) on postoperative day 1. Regarding the postoperative complications, the incidence of prolonged air leak was greater in the ELA group than in the GA group ($P = .05$). The causes of prolonged air leak in the ELA group included difficulty in locating the site of the air leak in 3 and failure to repair an air leak point because of fragile alveoli in 1 patient. The sole cause of prolonged air leak in the GA group was failure to repair the air leak point because of fragile alveoli in 3 patients. A total of 10 postoperative respiratory complications, 8 of pneumonia and 2 of acute respiratory distress syndrome (ARDS), developed in the GA group. No respiratory complications were observed in the ELA group, for a statistically significant difference between the 2 groups ($P = .046$). The duration of hospital stay was not significantly different between the 2 groups. Four hospital deaths were recorded in the GA group. The cause of death was pneumonia in 2 patients and ARDS in 2 patients. No hospital deaths were observed in the ELA group, which, however, did not show a statistically significant difference between the 2 groups.

Propensity Score-Matched Patient Study

The perioperative outcomes in the propensity score-matched groups are summarized in Table 3. The operating room stay was significantly shorter in the ELA group ($P = .006$). The incidence of postoperative respiratory complications, including pneumonia and ARDS, was

significantly lower in the ELA group than in GA group ($P = .02$). The duration of hospital stay and the incidence of hospital death were not significantly different between the 2 groups.

DISCUSSION

SSP results in a greater risk than primary spontaneous pneumothorax because it decreases further the pulmonary function of a patient with an already compromised pulmonary function. Therefore, even if minor SSP is detected, the patient should be admitted to the hospital for at least 24 hours, and supplemental oxygen therapy should be administered according to the British Thoracic Society guidelines.⁸ Most patients could require chest drain insertion. The cases of persistent air leak should be discussed with a thoracic surgeon; however, patients with SSP are often poor surgical candidates because they usually have poor lung function and have a high risk of complications from GA. A previous report advocated that if surgery is deemed unsuitable because of the associated significant risks in some patients with SSP, awake surgery should be performed by experienced surgeons.⁹ Pompeo and Mineo¹⁰ and Pompeo and colleagues¹¹ also reported that awake VATS bullectomy for primary spontaneous pneumothorax was a feasible option and provided an equivalent outcome compared with procedures performed under GA. However, the efficacy, feasibility, and safety of awake surgery for SSP are still controversial.

The main findings of our study were that awake VATS in patients with SSP reduced the operating room stay and postoperative respiratory complications compared with VATS under GA. In our patients, by eliminating the recovery time from GA, the duration of the operating time stay was significantly shorter in the ELA group, despite a similar operating time in both groups. More importantly, awake VATS significantly reduced the incidence of postoperative

respiratory complications, including pneumonia and ARDS. Although the reasons for the decreased incidence of respiratory complications in the ELA group is not completely clear, it can be associated with the avoidance of intraoperative pulmonary barotraumas by mechanical ventilation.¹² Furthermore, deglutition function might not be affected by surgery in the ELA group, resulting in a lower prevalence of latent aspiration that can potentially cause pneumonia.

However, in entire study sample, the incidence of prolonged air leak longer than 7 days after the operation was greater in the ELA group than in the GA group. This seemed to be primarily due to difficulty in finding the air leak points in VATS under ELA because most surgeries in this group were performed with the patient in the supine position, and water-sealing tests with positive airway pressure are impossible in the ELA group. The duration of postoperative hospital stay and the incidence of hospital death were not significantly different between the 2 groups in the entire patient and propensity score-matched patient studies. However, it is noteworthy that no hospital death was recorded in the ELA group. Additional studies are necessary to compare the safety of VATS under ELA and GA.

The main limitations of the present study were its retrospective nature and the significant discrepancy in the patient numbers in each group. We did not establish definite criteria for the indication for ELA or GA. ELA, however, was applied to patients with more compromised general conditions, as determined by a greater preoperative performance status and greater oxygen requirement in this group of patients. It seems clear that the lower incidence of postoperative respiratory complications in the ELA group did not result from patient selection. This was ensured by the results of the propensity score-matched comparison, which also showed a lower

incidence of postoperative respiratory complications in the ELA group.

CONCLUSIONS

We advocate awake VATS as a feasible surgical option that could be performed with an acceptable overall morbidity for patients with intractable SSP. Additional studies are desirable to more accurately evaluate the feasibility and safety of awake VATS in the treatment of SSP.

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