Original Article

Conversion method to manage surgical difficulties in non-intubated uniportal video-assisted thoracic surgery for major lung resection: simple thoracotomy without intubation

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Background: The major limitations of widespread use of non-intubated thoracic surgery (NITS) is the fear of managing complications. Here we present our practice of converting from uniportal video-assisted thoracic surgery (VATS) NITS to open NITS in cases of surgical complications.

Methods: The study period was from January 26, 2017, to November 30, 2018. Total intravenous anesthesia was provided with propofol guided by bispectral index, and the airway was maintained with a laryngeal mask with spontaneous breathing. Local anesthesia with 2% lidocaine at the skin incision, and intercostal and vagus nerve blockades were induced using 0.5% bupivacaine. For conversion with surgical indications, a thoracotomy was performed at the incision without additional local or general anesthetics.

Results: In 160 complete NITS procedures, there were 145 VATS NITS and 15 open NITS (9 conversions to open NITS and 6 intended NITS thoracotomies). In the 15 open NITS cases (2 pneumonectomies, 1 bilobectomy, 1 sleeve lobectomy, 7 lobectomies, 3 sublobar resections, 1 exploration), the mean operative time was 146.7 (105–225) and 110 (75–190) minutes in the converted and intended open NITS groups, respectively. There were no significant differences between systolic blood pressure (P=0.316; 95% CI, −10.469 to 3.742), sat O2% (P=0.27; 95% CI, −1.902 to 0.593), or propofol concentration in the effect site (P=0.053; 95% CI, −0.307 to 0.002) but significant differences in pulse (P=0.007; 95% CI, −10.001 to −2.72), diastolic blood pressure (P=0.013; 95% CI, −9.489 to −1.420) and in end-tidal CO2 (P=0.016; 95% CI, −7.484 to −0.952) before versus after thoracotomy, but there was no clinical relevance of the differences.

Conclusions: For conversion with surgical indications during the VATS-NITS procedure, NITS thoracotomy can be performed safely at the site of the utility incision without the need for additional drugs, and the major lung resections can be performed through this approach.

Keywords: Non-intubated thoracic surgery (NITS); video-assisted thoracic surgery (VATS); conversion; thoracotomy

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Introduction

Video-assisted thoracic surgery (VATS) has been developed to minimize surgery-inflicted tissue injury, thereby improving patient outcomes (1). Theoretically, combining VATS with the non-intubated thoracic surgical (NITS) approach, especially when spontaneous breathing is

maintained throughout, induces the least potential stress on patients; hence, it could be most beneficial for patients undergoing lung resection (2). The VATS-NITS method for major lung resections is used mainly in dedicated centers, and its widespread use is mainly inhibited by a doubt: "Is this procedure safe enough for patients, and how could we perform a quick conversion if needed?" Currently, in the case of unexpected complications during NITS, the recommended solution is the conversion to open thoracotomy that is preceded by muscle relaxation, the insertion of a double-lumen endotracheal tube and controlled mechanical ventilation has been the gold standard and routine for several decades (3,4). Complications during NITS may be due to anesthesiologic and surgical reasons alike. In cases of surgical complications, which are mainly technical difficulties, intubation and conversion to thoracotomy is the recommended method (4), but intubation can sometimes be very difficult and even planned endotracheal intubation with a double-lumen tube has a significant complication rate (5).

Here we report our practice of managing surgical difficulties during uniportal VATS-NITS major lung resection.

Table 1 Patient characteristics

Characteristics	N=166
Female/male	104/62 (62.6%/37.4%)
Mean age (years)	63.9 [20–81]
Conversion to intubation (3 anesthesia and 3 surgical indications)	6 (3.7%; 6/166)
Complete NITS procedure	160 (96.3%)
VATS-NITS procedures	145
Lobectomy	100
Segmentectomy	18
Wedge resection	22
Lung volume reduction	2
Empyema decortication	2
Rib resection	1
Open NITS procedures	15
Conversion from VATS to NITS thoracotomy (surgical indication)	9 (5.8%; 9/154)
Intended NITS thoracotomy	6

NITS, non-intubated thoracic surgery; VATS, video-assisted thoracic surgery.

Methods

Patients

Between January 26, 2017 and November 30, 2018, 166 thoracic surgical procedures were performed using the uniportal VATS-NITS method. Patient characteristics are summarized in *Table 1*. Six of the 166 patients required intubation during surgery: 1 had serious diaphragm and mediastinal movements, 2 had blood in the airways (anesthesiologic indications for conversion), and 3 had severe adhesions (surgical indication for conversion) requiring isolation with a double-lumen tube. The conversion rate to intubation with anesthesiologic indication and the following thoracotomy was 1.8% (3/166). In 160 cases, the NITS procedure was completed. In 145 NITS-VATS cases, the uniportal procedure was performed; however, 15 cases required conversion to open NITS (NITS with thoracotomy). The characteristics of these 15 open NITS patients are shown in *Tables 2* and *3*. For each patient, the NITS procedure was explained and the risks were detailed. If the patients agreed with this method, written informed consent was obtained from all patients.

Surgical selection criteria for VATS-NITS procedure

Because the surgical technique of the VATS-NITS procedure is the same as in intubated cases, the indications are also similar. According to the recommendations of a recent consensus meeting, patients mainly with lung cancer less than 7 cm, N0 and N1 cases are scheduled for VATS in our practice as well (1). Regarding the NITS itself, patients who are otherwise planned to undergo the VATS procedure with a body mass index (BMI) less than 30 without other exclusion criterias are indicated for NITS operation (*Table 4*).

Surgical procedure

We performed the same VATS uniportal method during the NITS procedures as was mentioned in the literature (6); in our uniportal practice, we follow the recommendation and work of Gonzales-Rivas (7,8). The "uniportal" terminology is debated in the literature due to the size of the incision (9).

Due to the NITS, at the incision site in the 5th intercostal space in the middle axillary line, 2% lidocaine (5 mg/kg) skin and subcutaneous infiltration is administered. A few

Table 2 Characteristics of open NITS patients

Characteristics	N=15
Female/male	8/7
Mean age (year)	61.1 [52–73]
Conversion from VATS NITS to open NITS	9
Pneumonectomy	2
Sleeve right upper lobectomy	1
Lobectomy	5
Wedge resection	1
Intended NITS thoracotomy	6
Bilobectomy	1
Lobectomy	2
Segmentectomy (anatomical)	2
Exploration	1

NITS, non-intubated thoracic surgery; VATS, video-assisted thoracic surgery.

minutes later, the incision is performed. The size of the utility incision depends on the patient's BMI. If the chest wall is 3–6 cm wide due to the fat, the incision is about 6 cm, but in a thin patient, the incision can be 4 cm. Thus, incision size is unrelated to uniportal VATS if a single incision is made without rib retraction. After entering the thoracic cavity, the lung gradually becomes atelectatic. A plastic ring retractor is inserted to hold the soft tissue. The complete atelectasis develops in 7–10 minutes, but during this time an intercostal nerve blockade is given with 0.5% bupivacaine between the 2nd and 5th intercostal nerves and near the vagus nerve (right side in the upper mediastinum; left side in the aortopulmonary window). The total amount of bupivacaine is 0.5 mL/kg. We usually administer 4–5 mL 0.5% bupivacaine near the 2nd to 5th intercostal nerves. To deliver local infiltration close to the vagus nerve, we administer 0.5% bupivacaine 3–5 mL with a long or butterfly needle. The left side the vagus blockade is a little more difficult. In the aortopulmonary window, the pleura is

Table 3 Data of the open NITS patients

	Converted NITS thoracotomy (n=9)	Intended NITS thoracotomy (n=6)
BMI	24.3 [19–31]	24.7 [20–32]
FEV_1 (%)	61.7 [32–111]	60.3 [36–73]
DLCO (%)	60.5 [40–84]	47.5 [26–61]
Surgical time (min)	146.7 [105–225]	110 [75–190]
Drainage time (days)	3.6 [1–14]	5.1 [2–13]
Number of N2 lymph nodes	9.6 [4–24]	21.6 [10–29]
Adenocarcinoma	4	3
Squamous cell carcinoma	1	2
Neuroendocrine tumor	2	1
Carcinosarcoma	1	0
Benign lesion	1	0
IA	1	2
IB	1	0
IIA	0	0
IIB	3	0
IIIA	3	3
IIIB	0	1

BMI, body mass index; DLCO, carbon monoxide diffusion; FEV_1, forced expiratory volume in 1 second; NITS, non-intubated thoracic surgery; N2 lymph nodes, mediastinal lymph nodes.

Table 4 Exclusion criteria from non-intubated thoracic surgery

Hemodynamically unstable patients
INR >1.5
Sleep apnea syndrome
Anticipated difficult airway
BMI ≥30 kg/m^2
Persistent cough or high airway secretion
Elevated risk of regurgitation
Raised intracranial pressure, unable to cooperate
Procedures requiring lung isolation to protect the contralateral lung
Full anticoagulation before surgery

BMI, body mass index; INR, international normalized ratio.

elevated a little and the needle is inserted under the elevated pleura into the fatty tissue close to the vagus nerve, and 3–5 mL bupivacaine is injected toward the vagus nerve. This is not painful, and patients do not react during this maneuver. To the vagus nerve blockade, the lung must be touched gently because it is very sensitive to manipulation. We just lift up the lung with an instrument or sponge to visualize the vagus. At 2–3 minutes after the vagus blockade, the lung can be held with the ring forceps without coughing. After this point, the manipulations are the same as in an intubated VATS surgery. There was no cough at the time of the manipulation near or in the bronchus.

Conversion from VATS NITS to open NITS

At the beginning of our NITS practice, when any kind of complications or difficulties occurred during the resection that were difficult to manage using the VATS-NITS approach, the anesthesiologist was asked to intubate the trachea with a double-lumen tube and a thoracotomy was performed. This was done in six cases.

In one case, the reason for conversion was a metastatic lymph node around the right upper lobe; we asked the anesthesiologist to intubate the patient. Because the intubation was a little more difficult and longer than usual, we simply extended the skin incision and used a rib retractor to enlarge the wound to provide a better view to the thoracic cavity. Because the patient remained stable and there were no signs of anesthetic complications, we gradually performed a regular axillary thoracotomy and a right upper sleeve lobectomy without complications.

After this operation, we changed our practice: In case of any surgical difficulties during the VATS-NITS surgery that were not manageable through the VATS method and the patient was stable, we disregarded endotracheal intubation and proceeded with a regular axillary thoracotomy and resection as usual. At the end of the surgery, the thoracotomy is closed, a chest tube is inserted via another incision, and a serratus cannula is inserted for postoperative pain management.

Conversion to open NITS was required in 9 cases due to oncological reasons (lymph node infiltration) in 4, bleeding in 2, technical difficulty to the sleeve in 1, extended adhesion in 1, and palpation difficulty in 1. In cases of major bleeding, the judgment and management of the conversion is the same as in intubated VATS. In our practice, if we cannot control the bleeding with compression of the distal artery or it is on the main pulmonary artery (even if it can be control with compression), a thoracotomy is indicated. As the bleeding begins, if the patient is stable, there is no indication for intubation. Theoretically, if the situation was catastrophic (fortunately none of our cases), the thorax would be opened immediately, the bleeding controlled with a clamp or by hand, and intubation requested of the anesthesiologist with the patient in a lateral position : it would be performed via a laryngeal mask with a single-lumen tube and bronchial blocker under fiberoptic guidance.

However, we must stress that the real-life threatening situation is not the major bleeding from a large vessel; rather, it is bleeding into the airway. This is an immediately indication for intubation. In this situation, the bleeding volume is not serious, so we have time to turn the patient and intubate them normally. Using the LMA (LMA; Ambu Aura-i laryngeal mask), we can completely control the airway.

Intended open NITS

After the excellent results of the first 4 conversion cases from VATS-NITS to open NITS, in 6 patients with a low forced expiratory volume in 1 second [60.3% (36–73%)] and carbon monoxide diffusion [47.5% (26–61%)], we decided to perform a direct/planned/intended open NITS surgery after receiving patient permission. We performed intended axillary thoracotomies after VATS-NITS exploration of the thorax and infiltration of the intercostal spaces and the vagus nerve. Using this method, normal resections

were possible. The chest was closed over a drain, and a serratus cannula was inserted for pain management. The serratus anterior plane (SAP) block with cannula, which can be inserted intraoperatively or under ultrasonography guidance, provides prolonged anesthesia of the hemithorax with numbness over the thoracic area supplied by the lateral cutaneous branches of the T2–T9 spinal nerves. This can provide adequate pain relief effect after a thoracotomy. It is filled intraoperatively with bupivacaine (0.5 mg/mL) and followed by a continuous infusion of 5 mL/h for the first 36 hours (10). Patient data are shown in *Tables 2* and *3*.

Anesthesiology

The exclusion criteria of NITS are summarized in *Table 4*. In the operating room, in addition to standard monitoring (ECG, O_2 saturation, non-invasive blood pressure), depth of anesthesia monitoring by bispectral index (BIS; Medtronic Vista) and invasive blood pressure measurements are performed. Midazolam and fentanyl are administered prior to the surgery. Anesthesia is induced and maintained with propofol administrated via target-controlled infusion titrated to keep the BIS at 40–60 according to published recommendations (5). After adequate depth of anesthesia is achieved, a laryngeal mask is inserted for airway maintenance. Spontaneous breathing is also maintained throughout and ventilation is monitored with capnography. Oxygen and air mixture are supplemented via a T-piece and FiO_2 is titrated to keep the SpO_2 at above 92%.

Anesthetic indications for conversion

The most frequently occurring indications for intubation are the following:

(I) Hypoxemia: In case of SpO_2 <92% or PaO_2 <60 mmHg on 100% O_2, the operated (non-dependent) lung is reinflated. If this procedure cannot correct the hypoxemia, then endotracheal intubation is performed.

(II) Hypercapnia: If $PaCO_2$ >75 mmHg or pH <7.15, the operated lung is reinflated to eliminate CO_2: patients breathe spontaneously via LMA and we adjust the low PEEP and pressure support on the circle and the lung reinflates due to this positive pressure. If it fails, conversion is necessary.

(III) Bleeding in the airways: At the first sign of blood in the airway, immediate intubation is required. The airways are always checked via LMA with a fiber optic bronchoscope before and after the resection. If there is any sign of blood or other secretions, it must be suctioned prior to the reinflation.

Method of conversion from NITS to intubation

At the start of our NITS experience, the correct procedure for intubation was as follows: rotation of the operation table to backward as we could, intubation of the trachea with a single-lumen tube, and placement of a bronchial blocker under fiber optic guidance or the insertion of a double-lumen tube. After we had more experience with patient tolerability and difficulties with urgent intubations in the lateral decubitus position, our protocols changed. Currently, if conversion to intubation is necessary, an urgent chest tube is inserted, the wound is covered with a temporary bandage, and the patient is returned to the supine position. In this supine position, intubation is a simple procedure. The time from the decision of the intubation to the supine position is generally less than 2 minutes.

Method of anesthesiology in open NITS cases

If the patient is stable and there is no indication for intubation but the surgical difficulties cannot be managed with the VATS-NITS method, a thoracotomy can be done in NITS circumstances. For the thoracotomy, we do not change the anesthesia and no additional drugs are necessary. Generally, with the same drug administration as in the pre-thoracotomy period, we can keep the patient parameters in the normal range. We follow the ERAS (enhanced recovery after surgery) principles and try to avoid TEA (thoracic epidural anaesthesia) and its possibly hard sympatholytic effect. Therefore, we use TPB (thoracic paravertebral blockade) and the new SAP block. This block is in the new ERAS guidelines with TPB and might be useful after thoracotomies. Our experience absolutely confirmed this theory.

We use the same protocol for intended open cases. In 4 of 15 cases, some noradrenaline was necessary for a short period of time. The indication for the administration of noradrenaline is the low systolic blood pressure or the low mean arterial pressure (MAP). According to our practice, the MAP must be higher than 60 mmHg or the systolic blood pressure higher than 90 mmHg to ensure adequate organ and tissue filling pressure and blood flow. This practice is similar in intubated and non-intubated patients (*Table 5*).

Table 5 Anesthesia data before versus after NITS thoracotomy (converted and intended open NITS group)

Patient	PB/min	PA/min	sysRRB, mmHg	sysRRA, mmHg	diasRRB, mmHg	diasRRA, mmHg	O_2SATB%	O_2SATA%	$etCO_2$B, mmHg	$etCO_2$A, mmHg	CeB, mcg/mL	CeA, mcg/mL
1	89.4	87.4	124	115	68	64	97	97.6	50	49.4	2.62	3.02
2	96.6	93.8	109	118	62	68	96.6	97.6	48.2	63	3.02	3.2
3	65.2	66	106	116	62	70	98.8	99.2	35.2	34.2	3.16	2.8
4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
5	65.6	76.8	106	94	62	64	98.6	98.4	43.2	46.4	2.5	2.52
6	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
7	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
8	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
9	78.8	89.8	104	116	62	70	96.2	96.4	46.4	49	2.52	2.62
10	83	87.4	94	116	48	68	90.8	96.6	43.4	47.6	2.76	2.9
11	65.6	80	112	106	60	68	98.8	98.2	35.4	47.2	3	3.44
12	65.2	66.6	112	112	68	72	96.2	95	43	45	3.12	3.56
13	66.6	76	104	104	62	64	95	96.4	36.8	41.6	2.66	2.74
14	65.8	75.4	102	115	62	64	96.2	95.8	43.2	45.2	2.66	2.7
15	80.4	89.4	104	102	62	66	96.6	96.8	46	48.6	2.56	2.76
P value	0.007		0.316		0.013		0.270		0.016		0.053	
95% CI	−10.001 to −2.72		−10.469 to 3.742		−9.489 to −1.420		−1.902 to 0.593		−7.484 to −0.952		−0.307 to 0.002	

CeA, propofol concentration in the effect site after NITS thoracotomy (open NITS period); CeB, propofol concentration in the effect site before NITS thoracotomy (VATS-NITS period); CI, confidence interval for mean difference; diasRRA, diastolic blood pressure after NITS thoracotomy (open NITS period); diasRRB, diastolic blood pressure before NITS thoracotomy (VATS-NITS period); $etCO_2$A, end-tidal carbon dioxide pressure after NITS thoracotomy (open NITS period); $etCO_2$B, end-tidal carbon dioxide pressure before NITS thoracotomy (VATS-NITS period); NA, no data because the patients received minor and temporal noradrenalin to keep a mean arterial pressure (noradrenalin administration was ceased during surgery); NITS, non-intubated thoracic surgery; O2SATA, oxygen saturation after NITS thoracotomy (open NITS period); O2SATB, oxygen saturation before NITS thoracotomy (VATS-NITS period); PA, pulse after the NITS thoracotomy (open NITS period); PB, pulse before the NITS thoracotomy (VATS-NITS period); sysRRA, systolic blood pressure after NITS thoracotomy (open NITS period); sysRRB, systolic blood pressure before NITS thoracotomy (VATS-NITS period).

Statistical methods

Data of the pulse, systolic and diastolic blood pressure, sat O_2, end-tidal carbon dioxide pressure ($etCO_2$), and propofol concentration in the effect were collected from the anesthesiologic documentation. Two-way repeated measures analysis of variance was used to compare the means of the above noted variables before versus after thoracotomy during the NITS open surgery. The 95% CIs for the mean differences were calculated. Values of $P<0.05$ were considered statistically significant. The analysis was performed using IBM SPSS 24 statistical software.

Results

Among the open NITS cases, there were almost identical numbers of female and male patients; in contrast, among the VATS-NITS cases, there were almost twice as many female as male patients (*Tables 1* and *2*). There were no cases of perioperative mortality.

Anesthesiology

Regarding the 15 open NITS cases, there were no significant differences in systolic blood pressure (P=0.316; 95% CI,

–10.469 to 3.742), satO$_2$% (P=0.27; 95% CI, –1.902 to 0.593), or propofol concentration in the effect site (P=0.053; 95% CI, –0.307 to 0.002) but there were significant differences in pulse (P=0.007; 95% CI, –10.001 to –2.72), diastolic blood pressure (P=0.013; 95% CI, –9.489 to –1.420) and etCO$_2$ (P=0.016; 95% CI, –7.484 to –0.952) during the NITS surgery or before and after the thoracotomy. Despite these statistical findings, due to the open NITS procedure use in 11 patients, it was not necessary to change the anesthesiologic treatment after thoracotomy. In 4 patients, noradrenaline administration was necessary to maintain adequate MAP, but it was ceased toward the end of the surgery. Two patients after pneumonectomy were admitted to the intensive care for observation, but the other 13 were transferred from the recovery room to the ward.

Surgery

According to our preliminary experience, all parts of a lung resection including lymphadenectomy can be performed via open NITS just as with the conventional intubated way without complications (*Table 3*). We had no R1–2 resections. The operative time was a little longer in the converted cases because of the exploration until conversion (*Table 3*). The majority of the resections were lobectomies, and in the patients with a BMI ≤30, the mediastinum and the diaphragm movement did not disturb the resection. The only new experience was the softness of the airways without the endotracheal tube, which requires special attention during mediastinal lymphadenectomy. Most of our patients had advanced lung cancer with lymph node metastasis. There were 3 patients with a prolonged air leak longer than 5 days (20%; 3/15), and the mean drainage time in the 15 open NITS cases was 4.2 days (range, 1–14). The overall conversion rate with surgical indications (3 to intubation and thoracotomy; 9 to open NITS) was 7.5% (12/160). One patient who underwent surgery due to a serious hemoptysis for which a lower bilobectomy was done died 25 days postoperative of cardiac insufficiency. His preoperative lung functions were very limited as follows: forced expiratory volume in 1 second (26%), carbon monoxide diffusing capacity (26%), and VO$_2$max (13.9 mL/kg/min). His postoperative period was uneventful, and he was discharged on postoperative day 7 to rehabilitation.

Discussion

The most criticized part of the NITS procedure is the "unsafe" airway. Although the conversion from NITS to an intubated method depends on anesthesiologic and surgical indications, it is recommended in any difficulties during the NITS thoracic surgery that the patient be intubated and the surgical procedure continue in that manner (11). With our experiences and practice, we recommended distinguishing between anesthesiologic and surgical indications for the conversion because the different problems should be managed differently.

In a review article from Mineo, the overall conversion rate to general anesthesia was 0–9%, but it did not detail the rates of surgical versus anesthesiologic indications (11). The conversion rate of the Liua study was 7%, which could be reduced with more experience, but this article did not distinguish between anesthesiologic and surgical indications for conversion; rather, intubation was required for both (5).

Intubation in the lateral decubitus position can be difficult. In our practice, in case of conversion with anesthesiologic indication, we quickly cover the wound over a chest tube and turn the patient to the supine position, in which intubation is very easy, taking less than 2 minutes. In difficult intubation cases, we do not perform intubation in the lateral position. Other authors reported inserting a chest drainage tube during the intubation to prevent tension pneumothorax, but they did not turn the patients to the supine position first (11,12).

In our practice, the overall surgical indication for conversion was 7.5%, which is very similar to the data of other centers; most frequently, serious adhesion, mediastinal movement, and bleeding cause the conversion (11). At the beginning of our NITS procedure, we intubated for any complication, and surgical reasons caused 1.8% (3/166) of cases. Later we realized that in surgical difficulties, when the patient is stable, intubation is not necessary from the anesthesiologic point of view and a thoracotomy and all resections can be performed without it.

Although there were statistically significant differences between the data of pulse, diastolic blood pressure, and etCO$_2$ before versus after NITS thoracotomy, the changes were not dramatic and did not require any serious modification in the drug administration in 11 patients. Confidence intervals for the differences clearly present that, despite statistical significance, there is no clinical relevance of the differences. In 4 patients, to maintain MAP, minor and temporal noradrenalin administration was necessary but could be ceased during surgery. This shows that, in adequate intercostal and vagus nerve blockade, the thoracotomy procedure itself does not require any modification in the

NITS anesthesiology. In the literature, we did not find any articles analyzing long-term experiences or presenting metanalysis about open NITS procedures (5,11,12).

An open NITS surgery is feasible for any minor and major lung resection. As we demonstrated here, the pneumonectomy and even a sleeve resection can be performed under open NITS, but attention must be paid to prevent blood from entering the airway.

The other part of the oncological principles is lymph node management. As we demonstrated, a good number of mediastinal lymph nodes (N2) can be removed during open NITS (9.6 and 21.6) versus VATS-NITS in other centers (all the lymph nodes N1+N2: 17.2) (5). In a review article of NITS metastasectomy from Migliore (13) it is mentioned, that the main criticisms against the NITS is the difficulty of the mediastinal lymphadenectomy. In our practice, we did not find any difficulties in performing lymphadenectomy. The only technical difference from intubated cases is that in open NITS patients, the airways are soft because of the absence of the intratracheal tube, so preparation around this soft airway must be done carefully. Using our technique, no cases of cough or airway injury occurred during the peribronchial manipulation.

In conclusion, the anesthesiologic and surgical indications in cases of conversion in VATS-NITS should be strictly distinguished because of the different management approaches to these problems. The anesthesiologic difficulties required intubation, but if the patient's oxygenation and circulation are normal, intubation is not necessary to manage surgical difficulties and a simple thoracotomy can be performed. Using open NITS thoracotomy, every step of a major lung resection can be completed without additional risk for patients. Although we worked out a safety way for conversion in NITS procedures, we can't predict if the NITS or awake surgery for major lung resection will become more common in the future or not. Currently mainly the technical questions of the procedure are discussed in the literature, and only few studies are published with physiological and the positive immune effect of the NITS (14). As a safe conversion practice was presented and the long term physiological and cancer-related effect of the NITS are proved, the current judgment of the non-intubated thoracic procedures will be changed.

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Footnote

Conflicts of Interest: Al authors have completed the ICMJE uniform disclosure form (available at http://dx.doi.org/10.21037/jtd-19-3830). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The authors confirm that the research adhered to the conditions of the ethics committee of the institutions and confirm the provisions of the Helsinki Declaration. Patient data were retrieved retrospectively from our medical record system (Medsolution) and the patients' personal data were secured. Ethical permission number: 111/2017-SZTE.

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