APPLICATION OF MODIFIED LARYNGEAL MASK AIRWAY IN ENDOBRONCHIAL ULTRASOUND-GUIDED TRANSBRONCHIAL NEEDLE ASPIRATION

YU-PING LI[1], JIAN YANG[1], RUO-WANG DUAN[2], GE-NING JIANG[1], JIANG FAN[1], RU-MING ZHAO[1]
[1]Department of Thoracic Surgery, Shanghai Pulmonary Hospital, School of Medicine, Tongji University, Shanghai 200433, China
[2]Department of Anesthesiology, Shanghai Pulmonary Hospital, School of Medicine, Tongji University, Shanghai 200433, China

ABSTRACT

***Objective**: To investigate the application of modified laryngeal mask airway in endobronchial ultrasound-guided transbronchial needle aspiration (EBUS-TBNA). Methods 70 patients underwent bronchoscopy from March 2012 to June 2012. 46 patients under intravenous anesthesia with sufentanyl and propofol and then received modified laryngeal mask airway for EBUS-TBNA, while 24 patients with local anesthesia received only 2% lidocaine for EBUS-TBNA. Systolic blood (SBP), diastolic blood pressure (DBP), heart rate (HR) and pulse oxygen saturation (SpO2) were recorded before examination (T1), at the endobronchial ultrasound probe insertion point (T2), and at 5 min (T3) and 10 min (T4) during examination, and at the end of examination (T5).*

***Results**: SpO2 was significantly higher in the general anesthesia group than in the local anesthesia group. In the general anesthesia group, SpO2 was also significantly higher in T2 than T1. There were significant differences in SBP, DBP and HR between two groups. Vital signs were more stable in the general anesthesia group than in the local anesthesia group. No patient in the general anesthesia group had memory of suffering after EBUS-TBNA.*

***Conclusions**: Modified laryngeal mask airway in EBUS-TBNA successfully solves the problem of breath management difficulties accompanying inspection and anesthesia sharing a common channel. It appears more comfortable for the patients.*

***Key words**: Laryngeal mask; EBUS-TBNA; Bronchoscopy.*

***Received** July 05, 2013; **Accepted** July 29, 2013*

Introduction

Endobronchial ultrasound-guided transbronchial needle aspiration (EBUS-TBNA) has emerged over the past decade as one of the most exciting and innovative developments in the field of respiratory medicine. In 2003, Krasnik et al. first reported the utility of convex probe EBUS-TBNA in sampling mediastinal nodes[(1)]. It is a minimally invasive method of mediastinal biopsy first reported in 2004 with a high diagnostic yield for the evaluation of mediastinal and hilar lymph nodes[(2)]. Diagnostic accuracy is at least equivalent to mediastinoscopy in the evaluation of mediastinal lymph node metastases in lung cancer[(3)].

In centers where EBUS-TBNA is available, it has supplanted mediastinoscopy as the procedure of choice for investigating mediastinal or hilar lesions, so EBUS-TBNA is being performed with increasing frequency. In light of these developments, it became important to develop an office-based outpatient anesthesia technique for this minimally invasive procedure. Original reports described introduction of the dedicated convex-probe ultrasound bronchoscope into the airway via an artificial airway (e.g. endotracheal tube or laryngeal mask) under general anesthesia[(4)].

EBUS-TBNA presents several unique issues from an anesthesiologist's viewpoint, including the fact that it requires sharing the airway with the bronchoscopist. Therefore, we designed a modified laryngeal mask (Patent Number: ZL200720073540.8) which succeeded in solving this issue.

The technologies in EBUS-TBNA have been carried out since 2009. Intravenous anesthesia schemes have been adjusted by combination with years of experience in clinical practice. The authors have successfully performed EBUS-TBNA on more than 1400 patients on an outpatient basis without any major complications. In this study, the operation and comparison of EBUS-TBNA was performed by adopting modified laryngeal mask and combination with optimized intravenous anesthesia and local anesthesia, so as to observe and analyze the clinical effect of this technology.

Methods

Subjects

70 patients who were found to have mediastinal lymphadenectasis and were required to undergo EBUS-TBNA for a definitive diagnosis were selected when they were admitted to our hospital for treatment from Mar. 2012 to Jun. 2012 (American Society of Anesthesiology(ASA) stage I or II, female or male, 21-77 years). All the patients in the group of general anesthesia underwent voluntarily EBUS-TBNA under laryngeal mask airway, and signed informed consent form and the study was approved by the Ethics Committee of our hospital.

Grouping

Group of general anesthesia: 46 patients were inserted with modified laryngeal mask airway (Patent No.: ZL200720073540.8) under rapid-sequence intravenous induction of anesthesia and then underwent EBUS-TBNA. During the examination, the respirator was used to control breathing, and pure oxygen was inhaled (3 L/min).

Group of local anesthesia: the heads of 24 patients were made backward, and the lower jaw was made lifted to fully expose throat. 2% lidocaine was sprayed onto the throat for anesthesia by using the sprayer with hands, 6 times each, 2 times for each nasal cavity, with the interval of 2-3 min for 3 cycles. The total volume of 2% lidocaine was 1-2 mL (about 20 times can be sprayed for 1 mL). The patients underwent transnasal bronchoscopy placement and then EBUS-TBNA. Pure oxygen (3 L/min) was inhaled through a side of nasal cavity during the examination.

Modified laryngeal mask

A dedicated laryngeal mask for supporting fiber-optic bronchoscopy under general anesthesia includes an airway tube, mask capsule set on the front end of airway tube and inflation valve which was connected to mask capsule through airway tube, which is characterized in that there is a sub-airway tube in the rear end of the airway tube (Figure 1 and Figure 2). The patients under examination are inserted with this modified laryngeal mask after they are given muscle relaxation. Then the examination or surgery is completed for the patients, and the combination of unique inflatable mask does not affect the movement and work of endotracheal intubation.

Optimizing Intravenous Anesthesia

The patients were asked in detail about their medical histories before anesthesia. They underwent the conventional ECG monitoring after entering the room, and then experienced opening venous access and were infused with 0.9% saline.

Meanwhile, the patients are preoxygenated through a nonrebreathing face mask at 10 to 12 L/min. Small doses of sufentanil (0.4-0.6 μg/kg) are given for induction. A small bolus of propofol (1.5-2 mg/kg) then given to obtain loss of consciousness as detected by loss of eyelid reflex. Mask ventilation is then performed before a muscle relaxant (succinylcholine 1-1.5 mg/kg) is given. Once the patient is adequately paralyzed, the modified LMA is inserted and confirmation of placement is performed by end-tidal CO_2, auscultation, and EBUS-TBNA. A size 3 LMA was used for female patients and a size 4 LMA for male patients. Propofol infusion is titrated to maintain an adequate depth of anesthesia (0.5 mg/kg/h). Muscle relaxation (succinylcholine 1-1.5 mg/kg) is continued as needed throughout to prevent reflex coughing and laryngospasm during the procedure. After the end of examination, propofol and succinylcholine infusions were stopped, and 0.4 mg naloxone was injected intravenously for antagonism instead.

Muscle relaxant should then be reversed and spontaneous ventilation resumed before the patient is extubated. The patient is then oxygenated via a nonrebreathing face mask transferred to the recovery area. Patients are observed routinely for adequate recovery and routine discharge criteria before being discharged home.

Outcome Measures

The systolic blood (SBP), diastolic blood pressure (DBP), heart rate (HR) and pulse oxygen saturation (SpO_2) before examination(T1), at the endo-

bronchial ultrasound probe insertion point (T2), 5 min (T3) and 10 min(T4) during examination, at end of examination (T5) were observed and recorded. The number of chocking, suffocation and body movement, number of suspending the operation by the operator, presence and absence of cardiovascular and other complications and the operative time during the operation were recorded. The follow-up was performed within 24 hours after surgery to find whether nausea, vomiting, sore throat and intraoperative awareness existed. The post-operative in-bed time was recorded.

Statistical analysis

SPSS 17.0 was used for statistical analysis, mean ± SD for measurement data, t test for inter-group comparison and analysis of variance for intra-group comparison. $\chi 2$ test or fisher exact test was adopted for adverse reactions indictors and other measurement data. $P < 0.05$ was considered statistically significant.

Results

General data

Between March 2012 and June 2012, 75 patients were registered for the study and 70 cases were enrolled. Five patients did not proceed after registration because of advanced disease, leaving 70 available for analysis. This included 70 patients, randomized into two groups: Group A-46 (65.7%) patients who received sufentanil and propofol, then were inserted with modified laryngeal mask airway, and Group B-24 (34.3%) patients who received 2% lidocaine before the EBUS-TBNA. The characteristics of these 70 valuable patients are shown in Table 1.

Changes in SpO_2

No significant change was observed in SpO2 of both groups before examination (T1) (P>0.05). At the endobronchial ultrasound probe insertion point (T2), SpO_2 of the group of general anesthesia was significantly higher than that of the group of local anesthesia [(98.6±1.2)% vs (91.2±1.1)%, P<0.05]. No significant difference was found in SpO2 at T3, T4 and T5 between both groups (P>0.05). It's worth noting that SpO_2 significantly increased at the time points (T2, T3, T4 and T5) after modified laryngeal mask placement compared to that at T1 in the group of general anesthesia with a statistical difference (P>0.05) (see Table 2).

Variable	Total(n=70)	Group A(n=46)	Group B(n=24)	p value
Age, years(mean)	56.2±13.9	55.4±14.1	57.0±13.8	NS
Sex (F/M), n(%)	28(40)/42(60)	18(39)/28(61)	9(37)/15(63)	NS
Smoking habits, n(%)				
Smoker	35(50)	23(50)	12(50)	NS
Ex-smoker	3(4)	2(4)	1(4)	
Non-smoker	32(46)	21(46)	11(46)	
Previous EBUS-TBNA(yes/no), n(%)	2(5)	2(4)	0(0)	NS
Sufentanil dose, μg(mean)	NA	25.8±4.3	NA	NA
Propofol dose, mg(mean)	NA	248±30	NA	NA
Succinylcholine dose, mg(mean)	NA	127±16	NA	NA
Lidocaine dose, mg(mean)	NA	NA	365±80	NA
EBUS-TBNA duration, min(mean)	26.8±6.9	25.8±6.9	26.8±6.9	NS
Complications, n(%)	0(0)	0(0)	0(0)	NS

Table 1: Characteristics of patients in both groups.

	T1	T2	T3	T4	T5
Group of general anesthesia SpO2(%)	89.6±6.3	98.6±1.2*	99.2±1.0*	98.9±1.1*	98.8±1.0*
Group of local anesthesia SpO2(%)	90.2±5.6	91.2±1.1	98.8±1.1	99.1±1.2	98.9±1.0

Table 2: Comparison of SpO_2 levels at the different time points in both groups.
*Compared to T1, *: P<0.05*

Changes in heart rate (HR)

No significant change was observed in HR of both groups before examination (T1) (P>0.05). At the endobronchial ultrasound probe insertion point (T2), 5 min (T3) and 10 min (T4) when ventilating and the end of operation, HR of the group pf general anesthesia was lower than that of the group of local anesthesia (P<0.05) (Figure 2).

Fig. 2: Change trend of heart rate (HR) in both groups at T1-T5.

Changes in blood pressure (BP)

No significant difference was observed in BP of both groups before examination (T1) (P>0.05). At the endobronchial ultrasound probe insertion point (T2), 5 min (T3) and 10 min (T4) during ventilation and the end of operation, SBP and DBP of the group pf general anesthesia was lower than those of the group of local anesthesia (P<0.05) (Figure 3 and 4).

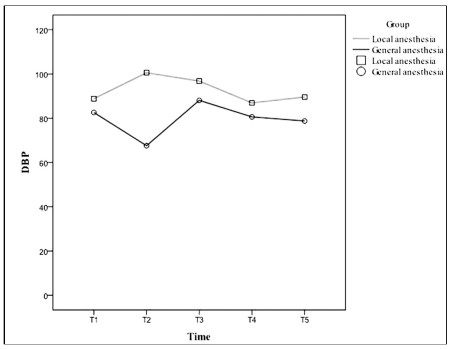

Fig. 3: Change trend of systolic blood pressure (SBP) in both groups at T1-T5.

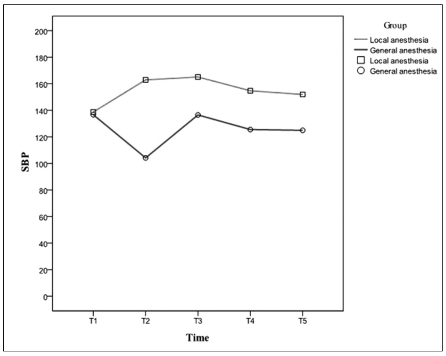

Fig. 4: Change trend of diastolic blood pressure (DBP) in both groups at T1-T5.

Patients' condition of the local anesthesia group

During the examination, the number of chocking, suffocation and body movement of the patients, number of suspending the operation by the operator in this group were significantly more than those of the group of general anesthesia [P<0.05] (Table 3). The adverse reactions within post-operative 24 hours were mainly limbs pain and laryngalgia in the group of general anesthesia. The headache, dizziness and other adverse reactions existed in individual patients, but most of them mitigated after 24 hours. No patient exhibited intraoperative awareness.

Discussion

As shown by the growing number of publications[5-10], EBUS-TBNA is becoming an important modality in the field of interventional pulmonology and thoracic surgery. The advantages of EBUS-TBNA include its minimally invasive nature, real-time targeting of lymph nodes, ability to access hilar, interlobar, and lobar lymph nodes, and safety. Therefore, it has been widely used in the mediastinal staging of lung cancer and in the diagnosis of mediastinal disease, and has demonstrated high diagnostic value in mediastinal pathology.

	Time points	Group of general anesthesia	Group of local anesthesia
		N(%)	*N(%)*
Chocking	T2	0(0)	22(91)*
	T3, T4, T5	0(0)	6(25)*
Suffocation	T2	0(0)	10(41.7)*
	T3, T4, T5	0(0)	4(16.7)*
Body movement	T2	0(0)	22(91)*
	T3, T4, T5	2(4.4)	6(25)*
Suspending the operation	T2	0(0)	3(12.5)*
	T3, T4, T5	0(0)	2(8.3) *

Table 3: Comparison of the occurrence of adverse reactions of both groups during examination.

However, EBUS-TBNA is different from bronchoscopy[11-17]: first ultrasound probe was added on fiberoptic bronchoscopy basis in EBUS-TBNA with the tuber diameter of 6.5 mm (longer than 4.8 mm, the diameter of the ordinary fiberoptic bronchoscopy) and greater irritation when passing glottis. Second, when performing EBUS-TBNA, the ultrasound probe is required to be close to tracheal carina or bronchial wall, and biopsy needle has a stronger irritation to tracheal carina and mucous membrane due to repeatedly passing through the trachea wall under ultrasound guidance; the bronchoscopy mainly performed the biopsy for the tumors projecting into the trachea with a small irritation. Third, EBUS-TBNA usually requires a biopsy of multigroup lymph nodes, and lymph node positions taken are different. EBUS-TBNA takes significantly longer than a conventional bronchoscopy and may therefore cause more discomfort. Fourth, some patients have a smaller diameter of lymph node collected with EBUS-TBNA and more blood vessels surrounding lymph node collected, so the operators must carefully puncture. The significant body movement of the patients under local anesthesia greatly increases the risk of bleeding caused by puncture.

Both anaesthesia care and procedural sedation services share the goals of providing the patient with comfort during a potentially distressing procedure while also ensuring that the operating physician has an acceptable working environment. This is why there are more and more medical groups that are interested in finding some form of sedation which ensures greater tolerance, comfort and cooperation during the test on the part of patients. Previous authors have suggested that EBUS-TBNA is best performed under general anesthesia via an artificial airway (e.g. endotracheal tube or laryngeal mask)[4].

Considering the large size of the ultrasonic bronchoscope, the EBUS bronchoscope can only fit in a size 8.5 or 9.0 inner diameter endotracheal tube (ETT) with adequate lumen around the probe for ventilation. A size 8.5 ETT was used for female patients and a size 9.0 ETT for male patients. The LMA with its large internal diameter seems to be the most suitable device to use to secure the airway and provide adequate ventilation around the bronchoscope. And laryngeal mask is not required to insert into the trachea and glottis, avoiding mechanical irritation of the trachea and larynx.

Another advantage of the LMA insertion for this procedure is that it allows for access to higher mediastinal lymph node stations that would otherwise be obscured by the ETT. Yasufuku also reported[18]: stations 2R and 2L were sometimes difficult to assess because of the presence of the endotracheal tube. They noted that the use of laryngeal mask airway obviates the limitation imposed by the endotracheal tubes.

A modified LMA (Patent NO.: ZL200720073540.8) was used in the majority of patients at the authors' institution. The authors designed and modified the ordinary laryngeal mask, making the rear end of airway tube have a sub-airway tube (Figure 1 and 2).

The end of sub-airway tube can connect a respirator or breathing balloon in order to control the breathing. The other end (EBUS-TBNA probe) entered the air passage to form a closed breathing circuit. The combined use of laryngeal mask and connecting tubes caused that fiberoptic bronchoscopy can freely pass in and out the laryngeal mask, trachea and bronchi, which solved successfully the difficult breathing management resulted from sharing a channel for the bronchoscopy and anesthesia. When applying in EBUS-TBNA, the clearing hole of the bronchoscope of modified laryngeal mask was increased to make it match with the probe of EBUS-TBNA. The patients under examination were inserted with this modified laryngeal mask airway after they underwent muscle relaxation; the examination can be completed for the patients, and the combination of unique inflatable mask did not affect the movement and work of intraluminal bronchoscope. The results from this experiment also showed that SpO_2 of the group of general anesthesia at T2 improved significantly compared to that of the group of local anesthesia, confirming the role of modified laryngeal mask in maintaining ventilation. Patients rarely desaturate because they are maintained on 100% oxygen throughout the procedure, which significantly reduce the complications. However, a number of patients required the insertion of endotracheal tubes instead of LMA. The indications for the ETT placement were difficult LMA placement, obesity, and severe untreated gastroesophageal reflux. The LMA may be subject to disadvantages. Protection against aspiration of gastric contents is less effective with an LMA compared with an endotracheal tube[19], there is always a risk of inadvertent dislodgment of the LMA, and therapy for complications of bronchoscopy (bleeding and bronchospasm) may be more difficult with an LMA. Although initially costly to purchase, LMAs are durable and reusable, a characteristic that offsets their initial cost.

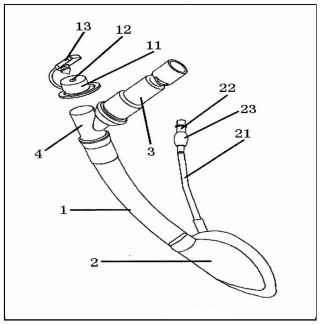

Fig. 1: Modified laryngeal mask. 1, Airway tube; 2, Inflatable mask capsule(unique inflatable mask structure does not affect the movement and work of endoluminal bronchoscope).The existing laryngeal mask products are easily blocked by barrier in the inserting process when bronchoscopy to cause that the examination cannot be carried out smoothly; 3, Sub-airway tube; 4; Three links; 11, Pipe cap (tough and thin rubber mold does not affect passing of the bronchoscope, but can seal it.); 12, Clearing hole of the bronchoscope; Tampon (it can close the pipelines of laryngeal mask to prevent leakage after removal of the bronchoscope); 21, Airway tube; 22; Inflation valve (can inflate to mask capsule); 23, Indicating gasbag.

Clarkson et al[20] conclude that propofol is a useful sedative agent in fiberoptic bronchoscopy with similar efficacy to midazolam but with a faster onset of action and a more rapid recovery.

Therefore, in the intravenous anesthesia program, the authors discarded midazolam and adopted propofol instead for induction and maintenance of anesthesia, thus the patients revived rapidly without fewer adverse reactions, and it is suitable for use in the outpatient EBUS-TBNA. The reasons for the use of sufentanil for anesthesia induction in the intravenous anesthesia program of this study were that the previous studies showed that sufentanil had a stronger affinity with opioid receptor compared to fentanyl and had a higher selectivity to μ1 receptor (analgesia) than μ2 receptor (respiratory depression)[21,22].

Especially for the elderly patients with hypertension, coronary heart disease and diabetes, it has a smaller cardiovascular responses and greater safety. Its inhibitory effect to respiratory and circulation can be alleviated by controlling the dose and postoperative use of naloxone for antagonism to accelerate revival and recovery of autonomous respiration. Our results show that patients inserted with modified laryngeal mask airway tolerate EBUS-TBNA better, remember less of the procedure itself and have a better predisposition to repeat the procedure.

The authors have found that total intravenous anesthesia (TIVA) provides optimal conditions for the bronchoscopist to perform needle aspirations in close proximity to major blood vessels in the mediastinum. In this study, the patients in the group of local anesthesia had obvious body movement, accompanied by choking, suffocation and others, all of which brought more inconvenience for precisely positioning the lymph nodes and puncture.

In 2 of all the patients, the operators were forced to suspend the operation due to significant reactions. Muscle relaxation is continued as needed throughout to prevent reflex coughing and laryngospasm during the procedure. Coughing can result in movement of the mediastinum with difficulty in obtaining an adequate view of the lymph node, accurate insertion of the needle, and possible injury to mediastinal major vessels. Scoline (succinylcholine), an ultrashort-acting muscle relaxant with a faster onset, stronger action and short effectiveness, can play the inhibition effect by motoneuron endplate depolarization.

Yoshino thought that 0.5 mg/kg succinylcholine was beneficial to LMA placement[23], Liou reported that the concurrent use of 1 mg/kg succinylcholine with etomidate might provide better results in terms of shortened time for the LMA insertion, jaw relaxation, and the success rate of LMA insertion than that of fentanyl[24]. In the operation process, the authors found the laryngeal mask in place, good open-glottis, smoothly passing through the glottis for fiberoptic bronchoscopy, no obvious choking, body movement and other reactions, moreover, it was also found that the patients had good myodynamia recovery without obvious impact on the wake-up time after completing the surgery. However, some patients exhibited varying degrees of muscle soreness and other complications after surgery which can be all considered tolerated and appeared mainly at 24 hours after surgery. The authors considered that the complications above may be caused by a large area of muscles twitch induced by the larger dose of succinylcholine, and the obvious postoperative muscle pain can be avoided by reducing the dose.

Continuous stimulation of the airway during the procedure results in the accumulation of large amounts of secretions that can predispose to excessive coughing, bronchospasm, and laryngospasm at the time of extubation. Adequate suctioning of secretions in the airway, tracheobronchial tree, and around the vocal cords with flexible bronchoscopy before extubation is essential. Because suctioning of secretions for EBUS probe is not ideal, the authors' unit usually uses flexible bronchoscopy instead for thoroughly suctioning of secretions. In addition, once neoplasm is found in the airway of the patients during the bronchoscopy, the flexible bronchoscopy can be also used smoothly instead for bronchoscopy and biopsy under the general anesthesia, avoiding the second bronchoscopy for the patients and reducing health-care costs.

Conclusions

EBUS-TBNA conducted with modified laryngeal mask airway under the general anesthesia can significantly reduce the number of choking, suffocation and body movement in the patients during the examination, and can also provide a good examination condition. Meanwhile, it also provides enough space for fiberoptic bronchoscopy in smoothly entering the trachea, shortens the treatment time and reduces the complications. Moreover, it ensures the safety and comfort of patients to the greatest extent. Due to the small sample size, further in-depth studies are needed.

References

1) Krasnik M, Vilmann P, Larsen SS, Jacobsen GK. *Preliminary experience with a new method of endoscopic transbronchial real time ultrasound guided biopsy for diagnosis of mediastinal and hilar lesions*. Thorax 2003; 58(12): *1083-6*.
2) Yasufuku K, Chiyo M, Sekine Y, Chhajed PN, Shibuya K, Iizasa T, Fujisawa T. *Real-time endobronchial ultrasound-guided transbronchial needle aspiration of mediastinal and hilar lymph nodes*. Chest 2004; 126(1): *122-8*.
3) Ernst A, Anantham D, Eberhardt R, Krasnik M, Herth FJ. *Diagnosis of mediastinal adenopathy-real-time endobronchial ultrasound-guided needle aspiration versus mediastinoscopy*. J Thorac Oncol 2008; 3(6): *577-82*.
4) Sarkiss M, Kennedy M, Riedel B, Norman P, Morice R, Jimenez C, Eapen G. *Anesthesia technique for endobronchial ultrasound-guided fine needle aspiration of mediastinal lymph node*. J Cardiothorac Vasc Anesth 2007; 21(6): *892-6*.
5) Yasufuku K, Chiyo M, Koh E, Moriya Y, Iyoda A, Sekine Y, Shibuya K, Iizasa T, Fujisawa T. *Endobronchial ultrasound guided transbronchial needle aspiration for staging of lung cancer*. Lung Cancer 2005; 50(3): *347-54*.
6) Yasufuku K, Nakajima T, Motoori K, Sekine Y, Shibuya K, Hiroshima K, Fujisawa T. *Comparison of endobronchial ultrasound, positron emission tomography, and CT for lymph node staging of lung cancer*. Chest 2006; 130(3): *710-8*.
7) Herth FJ, Eberhardt R, Vilmann P, Krasnik M, Ernst A. *Real-time endobronchial ultrasound guided transbronchial needle aspiration for sampling mediastinal lymph nodes*. Thorax 2006; 61(9): *795-8*.
8) Herth FJ, Annema JT, Eberhardt R, Yasufuku K, Ernst A, Krasnik M, Rintoul RC. *Endobronchial ultrasound with transbronchial needle aspiration for restaging the mediastinum in lung cancer*. J Clin Oncol 2008; 26(20): *3346-50*.
9) Kennedy MP, Jimenez CA, Bruzzi JF, Mhatre AD, Lei X, Giles FJ, Fanning T, Morice RC, Eapen GA. *Endobronchial ultrasound-guided transbronchial needle aspiration in the diagnosis of lymphoma*. Thorax 2008; 63(4): *360-5*.
10) Ernst A, Eberhardt R, Krasnik M, Herth FJ. *Efficacy of endobronchial ultrasound-guided transbronchial needle aspiration of hilar lymph nodes for diagnosing and staging cancer*. J Thorac Oncol 2009; 4(8): *947-50*.
11) Gu P, Zhao YZ, Jiang LY, Zhang W, Xin Y, Han BH. *Endobronchial ultrasound-guided transbronchial needle aspiration for staging of lung cancer: a systematic review and meta-analysis*. Eur J Cancer 2009; 45(8): *1389-96*.
12) Varela-Lema L, Fernandez-Villar A, Ruano-Ravina A. *Effectiveness and safety of endobronchial ultrasound-transbronchial needle aspiration: a systematic review*. Eur Respir J 2009; 33(5): *1156-64*.
13) Adams K, Shah PL, Edmonds L, Lim E. *Test performance of endobronchial ultrasound and transbronchial needle aspiration biopsy for mediastinal staging in patient with lung cancer: systematic review and meta-analysis*. Thorax 2009; 64(9): *757-62*.
14) Lee HS, Lee GK, Lee HS, Kim MS, Lee JM, Kim HY, Nam BH, Zo JI, Hwangbo B. *Real-time endobronchial ultrasound-guided transbronchial needle aspiration in mediastinal staging of non-small cell lung cancer: how many aspirations per target lymph node station?* Chest 2008; 134(2): *368-74*.
15) Hwangbo B, Kim SK, Lee HS, Lee HS, Kim MS, Lee JM, Kim HY, Lee GK, Nam BH, Zo JI. *Application of endobronchial ultrasound-guided transbronchial needle aspiration following integrated PET/CT inmediastinal staging of potentially operable non-small cell lung cancer*. Chest 2009; 135(5): *1280-7*.
16) Tremblay A, Stather DR, Maceachern P, Khalil M, Field SK. *A randomized controlled trial of standard vs endobronchial ultrasonography-guided transbronchial needle aspiration in patients with suspected sarcoidosis*. Chest 2009; 136(2): *340-6*.
17) Fujiwara T, Yasufuku K, Nakajima T, Chiyo M, Yoshida S, Suzuki M, Shibuya K, Hiroshima K, Nakatani Y, Yoshino I. *The utility of sonographic features during EBUS-TBNA for lymph node staging in patient with lung cancer-a standard EBUS classification system*. Chest 2010; 138(3): *641-7*.
18) Yasufuku K, Pierre A, Darling G, de Perrot M, Waddell T, Johnston M, da Cunha Santos G, Geddie W, Boerner S, Le LW, Keshavjee S. *A prospective controlled trial of endobronchial ultrasound-guided transbronchial needle aspiration compared with mediastinoscopy for mediastinal lymph node staging of lung cancer*. J Thorac Cardiovasc Surg 2011; 142(6): *1393-400*.
19) Douadi Y, Bentayeb H, Malinowski S, Hoguet E, Lecuyer E, Boutemy M, Lachkar S, Fournier C, Dayen C. *Anaesthesia for bronchial echoendoscopy:experience with the laryngeal mask*. Rev Mal Respir 2010; 27(1): *37-41*.
20) Clarkson K, Power CK, O'Connell F, Pathmakanthan S, Burke CM. *A comparative evaluation of propofol and midazolam as sedative agents in fiberoptic bronchoscopy*. Chest 1993; 104(4): *1029-31*.
21) Forestier F, Hirschi M, Rouget P, Rigal JC, Videcoq M, Girardet P, Durand M, Maitrasse B, Girard C, Lehot JJ, Du Grés B, Sellin M, Depoix JP, Janvier G, Longrois D. *Propofol and sufentanil titration with the bispectral index to provide anesthesia for coronary artery surgery*. Anesthesiology 2003; 99(2): *334-46*.
22) Xue FS, Liu KP, Liu Y, Xu YC, Liao X, Zhang GH, Li CW, Yang QY, Sun HT. *Assessment of small dose fentanyl and sulfentanyl blunting the cardiovascular responses to laryngoscopy and intubation in children*. Paediatr Anaesth 2007; 17(6): *568-74*.
23) Yoshino A, Hashimoto Y, Hirashima J, Hakoda T, Yamada R, Uchiyama M. *Low-dose succinylcholine facilitates laryngeal mask airway insertion during thiopental anaesthesia*. Br J Anaesth 1999; 83(2): *279-83*.
24) Liou CM, Hung WT, Chen CC, Hsu SC, Lau HK. *Improving the success rate of laryngeal mask airway insertion during etomidate induction by using fentanyl or succinylcholine*. Acta Anaesthesiol Taiwan 2004; 42(4): *209-13*.

Acknowledgement
This study was supported by the Program in Appropriate Technology Developed, Promoted and Applied by Shanghai Municipal Hospitals (SHDC12010214).

GE-NING JIANG
Department of Thoracic Surgery, Shanghai Pulmonary Hospital
Tongji University School of Medicine
507, Zheng Min Rd, Yangpu District
Shanghai, People's Republic of China