Original Paper

Application of a Simulator-Based Teaching Method in the Training of the Flexible Bronchoscope-Guided Intubation

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ABSTRACT: Background: The study aimed to explore the effect of a bronchoscopic simulator-based comprehensive teaching method in the training of flexible bronchoscope-guided intubation for suspected lung cancer patients for doctors without bronchofibroscopic operation background. Methods: We designed a prospective self-control study involved in 35 trainees from the Navy Military Medical University's affiliated hospital to evaluate flexible bronchoscope-guided intubation's training outcome. Before and after the practice training, we recorded the flexible bronchoscope passing time from nasal to visible glottis and carina, tracheal placement tube, and ventilation. Results: All 35 trainees could complete flexible bronchoscope-guided intubation independently after training. Conclusions: The bronchial diagnosis for suspected lung cancer patients and treatment-based model can be widely applied in tracheal intubation training.

KEYWORDS: *Bronchoscopy, Intubation, Methodology, Sedation, lung cancer, single nodule, radial- EBUS, convex probe EBUS, 22G needle, 19G needle.*

Introduction

Dealing with difficult airway is a typical clinical emergency. A prompt establishment of an artificial airway is the determination to rescue effectiveness. Flexible bronchoscope-guided intubation (FOI) was the accepted golden standard for solving difficult airways. Its role has been recognized as guidelines for managing both anticipated and unanticipated difficult airways [1,2].

Flexible bronchoscopy also played an essential role in the operation room and intensive care units, such as identifying double-lumen endotracheal tube and sputum suction under bronchoscope [1,2].

Anesthesiologists or important care unit (ICU) physicians must master the basic operation techniques of flexible bronchoscopy. The study aimed to evaluate the application effect of a comprehensive training method based on bronchial diagnosis and treatment model in the training of flexible bronchoscope-guided

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endotracheal intubation for doctors without flexible bronchoscopic operation background for suspected lung cancer patients. Lung cancer patients are usually diagnosed at advanced stage disease due to early disease symptoms. Most patients are admitted as outpatients to perform flexible bronchoscopy for the investigation of a single nodule, undiagnosed lymphadenopathy or staging of diagnosed lung cancer. In the case of single nodule we use a flexible bronchoscope with the help of radial endobronchial ultrasound [3-5].

Cone beam CT can also assist as a surrogate to the radial endobronchial procedure to proceed faster to a single nodule [6,7].

The procedure is usually performed under sedation or intubation with a tracheal tube or rigid bronchoscope depending on the evaluation of the medic due to the possible risks of every case [8].

Regarding staging of lung cancer and undiagnosed lymphadenopathy we use convex probe EBUS which is an endoscope with the addition of u/s on the tip next to the video camera [9,10].

Again, this procedure can be done as previously described as radial- EBUS. In order to acquire adequate sample for all bronchoscopic procedures we have to choose carefully all parameters such as ventilation and sedation.

Most of these patients have chronic obstructive disease (COPD) or heart failure due to smoking habit [11].

Methods

Trainees

There were 35 medics and anesthesiologists from the Navy Military Medical University-affiliated hospital who participated in this training, including 21 males and 14 females with an average age of 35.7 years old. None of the trainees had received any flexible fiberoptic bronchoscope (FOB) training or independently implemented bronchoscopy.

The study was approved by Navy Military Medical University. The comprehensive training courses, including basic theory and practice that lasted five weeks for 10 hours, were taught by Haidong Hang, a respiratory endoscopic expert from the Navy Military Medical University. Consent was acquired for the figures included in our manuscript.

Training Courses and Models

The comprehensive training courses, including basic theory and practice that lasted five weeks for 10 hours, were taught by Haidong Hang, a respiratory endoscopic expert from the Navy Military Medical University. Based on the "Respiratory Endoscopy Training Course" [1], theoretical courses were composed of bronchoscopic equipment introduction, tracheal anatomy, indications, and complications. The practice class was held after academic training. Based on the three-dimensional data of trachea trees reconstructed by trachea computed tomography (CT) in adult healthy men, a silicone rubber trachea tree model was established and cast with silicone rubber. (Figure 1)

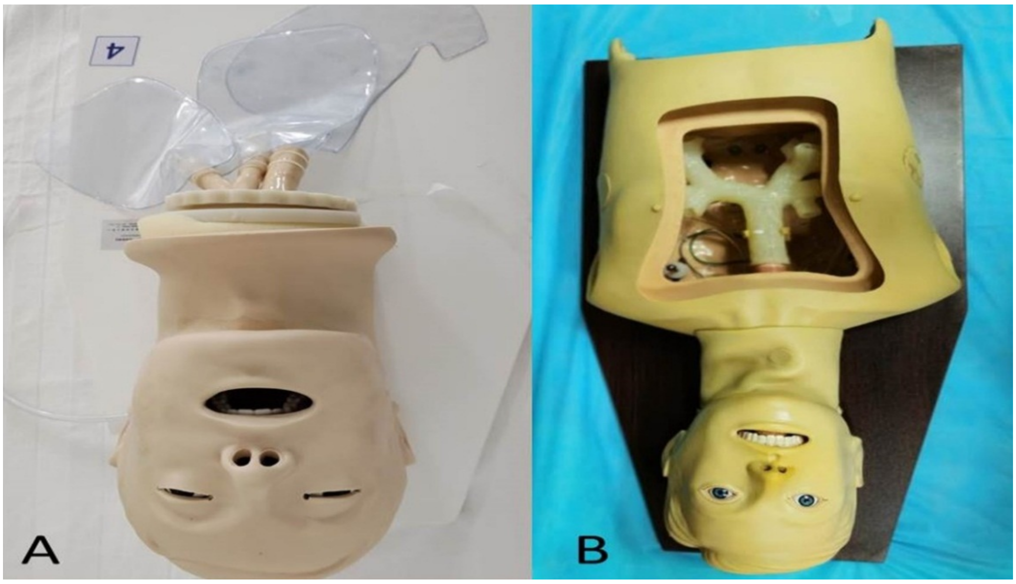

Figure 1. A is for traditional model; B is for our training model.

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A flexible diagnostic bronchoscope (Olympus Company, BF-180) was used for the FOI practical training. After the bronchoscope connected, trainees placed the FOB through a 7.0 inner diameter tracheal tube firstly, then inserted the FOB through nasal and started to count the time. Time of FOB from nasal to a visible glottis and carina, tracheal placement tube, and ventilation were recorded. The FOB Global Rating Scale (GRS) [2] was adopted to evaluate the procedure's fluency during the practical course (Table 1).

Table 1. The FOB Global Rating Scale (GRS) was adopted to evaluate the procedure's fluency during the practical course.

	1	2	3	4	5
View of central airway	Frequently loss view of central airway	-	Loss of view of central airway of more than once	-	Maintains central airway in center of field of view
Mucosal contact	Frequently or hard collision with mucosa	-	No collisions, infrequent glancing contact with mucosa	-	No mucosal contact
Progress	Hesitant, jerky or inaccurate attempts to progress	-	General progression, occasional hesitancy, some inaccuracy with initial movement	-	Progresses smoothly and accurately between sequential landmarks
Orientation	Image not oriented	-	Image usually oriented	-	Maintains orientation

In the second phase all trainees inserted a radial EBUS and a convex probe EBUS in order to become familiar with the technique and all procedure parameters. The trainees were trained with biopsy forceps and 22G and 19G needle for the convex probe. They became familiar with these techniques however; the purpose of the study was not to educate them in the ultrasound that is required for both biopsy techniques.

Outcome Assessment

During the training, each participant performed six-times' FOI operations and recorded the operating time and GRS score after understanding the operation specifications of the flexible bronchoscope. Mean time of three operations and GRS score were used as baseline data before training.

At the end of the training, each participant performed FOI six times and recorded the operating time and GRS score, the average time and GRS score being the final data.

At the end of the training, each participant performed three FOI sessions and recorded the time and GRS score, the average time and GRS score being the final data the primary outcome was the time to successfully complete FOI before and after the training course and GRS scores as the secondary result.

A questionnaire survey conducted the appraisal of the training effect for each trainee in this study.

All trainees became also familial with the necessary parameters of these patients which require specialized ventilation mode since they have COPD and heart failure of some degree.

Statistical Analysis

All variables (time and GRS score) were described as the mean and standard error. IPSS 21.0 paired T test was used for analysis to compare variables before and after training

Results

All of the thirty-five trainees could complete the procedure of FOI independently after training.

FOI's total time was markedly shorter after training than before (46.20±2.66s vs. 68.00±8.06s, $p<0.01$) (Figure 2A).

We divided the process of FOI into five periods: T1: from the beginning of an operation to see the glottis; T2: through the glottis; T3: after passing the glottis to see carina; T4:, placement of endotracheal tube; T5: removed the FOB. The results showed that the time of operating bronchoscopy was significantly reduced after the training, included T1, T2, T3 and T5.

Compared before training, the GRS scores of FOI were significantly improved after training (5.51±0.49 vs. 15.51±1.60, $p<0.01$).

The questionnaire survey showed that all trainees benefited from this comprehensive simulator-based teaching course. Each participant conducted 6 simulated operations.

According to the time consuming of each operation, it was found that the time consuming of the 4th, 5th and 6th operations was close to (5.51±0.49 vs. 6.01±0.60 vs.6.12±0.57, $p>0.01$), with no statistical significance (Figure 2B).

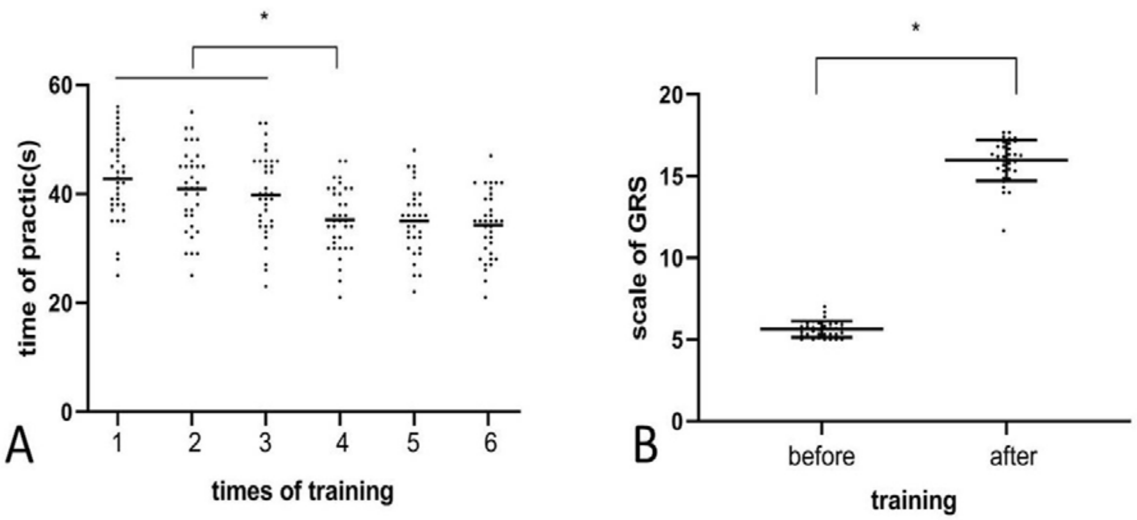

Figure 2. A. is showed that FOI's total time was markedly shorter after training than before (46.20±2.66s vs. 68.00±8.06s, *<0.01); B. is for According to the time consuming of each operation, it was found that the time consuming of the 4th, 5th and 6th operations was close to (5.51±0.49 vs. 6.01±0.60 vs.6.12±0.57, p>0.01), with no statistical significance.

Discussion

With the development of FOB equipment and accessories, the application of bronchoscope intubation is more and more extensive [2].

The endoscopic techniques are now so technically improved that can acquire biopsy sample from any lesion in every corner of the pulmonary parenchyma and lymph node station of the thorax.

While many reports regarding FOB training methods, such as instructional lectures and workshops with hands-on training on the patients under supervision, there was no consensus regarding the optimal approach for FOI training [2].

This commendatory training course generally includes two parts: theoretical training course and practical training course.

An academic training required in the Oxford fibreoptic training program called the pre-clinical module included introducing and demonstrating equipment and discussions on procedural skills [2].

Combined with the experience of bronchoscopy diagnosis and training for lung cancer from Changhai Hospital, this study focused on the tracheal anatomy and prevention of FOI operation.

Many researchers had reported about FOI training, such as using airway training mannequins [2], simulators [12], virtual reality trainers [13], and cadavers [14].

The advantages of using a simulator for practical training were high safety and ability to repeat practice at any time.

In addition, the ethical correctness would be questioned when s a novice is training a patient, as it is not when using a model [15].

The study had exhibited that using model training can improve the psychological motor skills of FOI students [16].

As technology advances, the simulator used for FOI training was constantly being updated and improved [17].

In our training, the bronchial tree model was based on silicon printed from three-dimensional CT reconstruction of the lungs of healthy adults, it can effectively simulate the structure of human trachea.

The results of the training suggested that using this simulator for FOI training had an optimal effect for the trainees in suspected lung cancer patients.

The comprehensive FOI training based on a bronchoscopic simulator had the following advantages.

Above all, the practical training operation was highly repeatable and could be performed without time-limited.

It was then extremely safe for trainees, in the whole training process, no targeting patients without doctor-patient contradictions and operational risks.

At last, trainees had a strong sense of participation, which could especially overcome nervousness as novices.

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Trainees had the time to operate on their own different equipment such as; radial EBUS and convex probe EBUS and check the ventilation parameter.

There were certain limitations to the study. Firstly, the research was a prospective self-controlled pilot study, and the number of participants was limited, only thirty-five trainees.

Secondly, although the self-made simulator could simulate the human trachea well, the lack of secretions and abnormal airway conditions might not fully and possibility of all difficult airways.

Although the self-made simulator can simulate the human windpipe well, the lack of secretions and abnormal airway conditions may not fully reflect the possibility of all difficult airways.

Moreover; the trainees were not educated in the ultrasound, but only in the biopsy forceps and 22G/19G needle apparatus. In any case ultrasound training is another issue.

Conclusions

In conclusion, the simulator-based teaching method has obvious effect in the FOI training, which is worth popularizing among grassroots doctors lacking bronchoscopy training.

We should make training of endoscopic techniques for suspected lung cancer patients easily accessible to several centers and not only centers of expertise.

Abbreviations

(FOI)-Flexible bronchoscope-guided intubation
(COPD)-chronic obstructive disease
(GRS)-Global Rating Scale
(FOB)-Flexible fiberoptic bronchoscope
(CT)-computed tomography
(FOI)-Fiberoptic intubation

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Qianbo Chen, Zhenli Hu, Qing Wang, Yuguang Yang and Min Li share equal contributions to this work.

Conflict of interests

None to declare

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